INFLATION DYNAMICS IN TURKISH ECONOMY:

A DISAGGREGATED PHILLIPS CURVE APPROACH

Master's Thesis

Anıl TUĞRAL

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MASTER'S THESIS

Department of Economics

Supervisor: Asst. Prof. Dr. Bilgin BARİ

Eskişehir

Anadolu University

Graduate School of Social Sciences

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ABSTRACT

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This thesis aims to analyze the inflation dynamics in the Turkish economy by adopting a disaggregated Phillips curve approach. Phillips curve, which is the focus of this thesis, is a mostly used theoretical concept that shows the relationship between the inflation rate and economic activity. Based on this theoretical framework, this study presents six different models for subcomponents of the Consumer Price Index alongside the aggregated model. These models employ the quarterly data between 2003Q1-2020Q1. The descriptive analysis reveals that the Turkish economy has a structural inflation problem due to foreign-source dependency. Also, the findings of econometric models support this phenomenon. According to the results, the backward-looking indexation (inertia) is very high in each sub-group. Also, the output gap creates upward-pressure on prices with some lags, in general. However, the aggregated model does not catch this effect. Besides, cost shocks come from the exchange rate, and related subcomponents of import unit price index drive inflation through various channels in the quite short-term. Moreover, the stronger long-run effects of these shocks deteriorate pricing behaviors and make inflation a structural problem for the Turkish economy.

Keywords: Disaggregated Phillips curve, Consumer price index, Inflation rate, Turkish economy

ÖZET

TÜRKİYE EKONOMİSİ'NİN ENFLASYON DİNAMİKLERİ: AYRIŞTIRILMIŞ PHILLIPS EĞRİSİ YAKLAŞIMI

Anıl TUĞRAL

İktisat Bölümü

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Tez Danışmanı: Dr. Öğr. Üyesi Bilgin BARİ

Bu tez, ayrıştırılmış Phillips eğrisi analizi kullanarak Türkiye ekonomisinin enflasyon dinamiklerini incelemeyi amaçlamaktadır. Bu tezin odak noktası olan Phillips eğrisi enflasyon oranı ve ekonomik aktivite arasındaki ilişkiyi incelemek adına sıklıkla başvurulan bir teorik çerçevedir. Bu teorik çerçeve altında, bu çalışma Tüketici Fiyat Endeksi ve onun altı alt başlığını inceleyen modeller sunmaktadır. Bu modeller 2003:1-2020:1 dönemlerine ait çeyreklik verileri kapsamaktadırlar. Betimsel analizlerin sonuçları Türkiye'nin ithal girdi bağımlılığından kaynaklanan bir yapısal enflasyon problemi olduğunu gözler önüne sermektedir. Ayrıca modellerden elde edilen bulgular bunu desteklemektedir. Sonuçlar her bir alt grubun fiyatlarında geriye dönük endekslemenin oldukça yüksek olduğunu göstermektedir. Ayrıca, çıktı açığı fiyatlar üzerinde bir baskı oluşturmaktadır. Fakat ayrıştırılmamış model genellikle gecikmeli değerlerde görülen bu etkiyi yakalayamamaktadır. Bunların yanı sıra, döviz kurundan ve ithalat birim fiyat endeksinin ilgili alt başlıklarından gelen maliyet şoklarının fiyatlar üzerindeki etkileri çok hızlı bir şekilde gerçekleşmektedir. Bu şokların çok daha kuvvetli olan uzun dönem etkileri fiyatlama davranışlarını bozmakta ve enflasyonun Türkiye ekonomisi için yapısal bir problem haline gelmesine sebep olmaktadır.

Anahtar Kelimeler: Ayrıştırılmış Phillips eğrisi, Tüketici fiyat endeksi, Enflasyon oranı, Türkiye ekonomisi

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18/09/2020

STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific ethical principles and rules throughout the stages of preparation, data collection, analysis and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with "scientific plagiarism detection program" used by Anadolu University, and that "it does not have any plagiarism" whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

Anıl Tuğral

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LIST OF SYMBOLS AND ABBREVIATIONS

ADF : Augmented Dickey-Fuller

AGR : Ratio of Agricultural Sector in GDP

ARDL : Autoregressive Distributed Lag

CBRT : Central Bank of the Republic of Turkey

CPI : Consumer Price Index

CPI_0 : The Variable for General CPI

CPI_1 : The Variable for the Group of Food and Non-Alcoholic Beverages in CPI

CPI_3 : The Variable for Clothing and Footwear in CPI

CPI_4 : The Variable for the Group of Housing, Water, Electricity, Gas, and Other Fuels in CPI

CPI_5 : The Variable for the Group of Furnishings, Household Equipment, Routine Maintenance of the House in CPI

CPI_7 : The Variable for the Group of Transport in CPI

CPI_{11} : The Variable for the Group of Hotels, Cafes, and Restaurants in CPI

CUSUM : Cumulative Sum of Squares

D : Dummy Variable

DSGE : Dynamic Stochastic General Equilibrium

ECM : Error Correction Model

EDDS : Electronic Data Delivery System

EXC : Exchange Rate

GAP_m : The Output Gap Derived from the M2 Money Supply

GAP_y : The Output Gap Derived from the Industrial Production Index

GDP : Gross Domestic Product

GFC : Global Financial Crisis

GMM : Generalized Method of Moments

GMNKPC : Gali and Monacelli‘s New Keynesian Phillips Curve

GUM : General Unrestricted Model

IMP : Import Unit Price Index

IMP_d : Import Unit Price Index for Durable Goods

IMP_f : Import Unit Price Index for Food Materials

IMP_s : Import Unit Price Index for Semi-durable Goods

IMP_v : Import Unit Price Index for Materials of Vehicles

INT_h : Average Interest Rates on Houses

INT_v : Average Interest Rates on Vehicles

IPI_w : Average Production Index for Clothing and Footwear

IT : Inflation Targeting

NAIRU : Non-accelerating Inflation Rate of Unemployment

NKPC : New Keynesian Phillips Curve

OECD : Organization for Economic Cooperation and Development

OIL : Europe Brent Oil Prices

PC : Phillips Curve

PP : Phillips-Perron

PPI : Producer Price Index

TL : Turkish Lira

UK : United Kingdom

US : United States of America

USD : United States Dollar

VAR : Vector Autoregressive

TOU : Number of Tourists

1. INTRODUCTION

The inflation rate is one of the most crucial variables in the economy since it is an indicator of the power of a currency. The low and stable inflation rate provides a reliable economic environment, and it directly affects the durability of an economy. For that reason, the inflation rate is the most crucial target variable for almost all monetary authorities all around the world. Also, economists have investigated the causes and effects of the inflation rate for many years. The present study aims to take a step further in this investigation.

Most studies on inflation dynamics are based on the Phillips' (1958) study and the concept of the Phillips curve (PC) that shows the negative relationship between inflation and unemployment. This concept has improved over the years, and it has transformed into one that explains inflation dynamics. However, most approaches analyze inflation dynamics as a whole and ignore the differences across sectors. In contrast, this study explains the inflation dynamics in Turkey by using a disaggregated PC approach.

In line with this objective, the study opens with examining the inflation background of Turkey in a descriptive approach. Before the econometric analyses, descriptive statistics present some valuable insights about inflation dynamics in Turkey. First, Turkey has a chronic inflation problem. In many years, the Turkish economy experiences two and three-digit inflation rates. One of the biggest reasons for this experience is the foreign-source dependency of the Turkish economy. As a result of this dependency, the exchange rate significantly affects prices in Turkey through energy prices and imported intermediate goods.

The present study estimates seven Autoregressive Distributed Lag (ARDL) models to explain the inflation dynamics in the Turkish economy. The first model examines the overall inflation rate in the Turkish economy, and other models focus on inflation dynamics in six subcomponents of the Consumer Price Index (CPI). These models reveal some facts about inflation dynamics. In the model for overall CPI and sub-models, the exchange rate and import prices significantly affect the inflation rate both in the short-run and long-run. On the other hand, demand pressure on the inflation rate manifests itself in the short-run. So, the production costs that are sensitive to exchange rates are the most significant driver of the inflation rate in Turkey. Furthermore, disaggregated models reveal that each sub-models have sui generis explanatory variables.

The study proceeds as follows: This section includes the main goal of this study and discusses Turkish inflation dynamics in a descriptive approach. Section 2 presents a comprehensive theoretical background of the PC. Moreover, Section 3 bunches the empirical model, literature review, estimation method, and data. Then it presents the estimation results of the models. Finally, Section 4 concludes with a review and policy recommendations.

1.1. Motivation, Aim, and Scope

The literature includes a great variety of studies on the inflation dynamics in Turkey. Most of them focus on the data on the aggregated level. However, this kind of approach ignores the heterogeneity of pricing behaviors across different sectors. Despite this, the number of studies that examine pricing dynamics in Turkey considering a bottom-up approach is a minute amount. The primary motivation of this study is this sort in the literature and the thought that a disaggregated approach can bring a new and better perspective for inflation dynamics in Turkey.

This thesis defense that inflation is a structural problem in the Turkish economy. Accordingly, the purpose of the thesis is to analyze inflation dynamics in Turkey in a disaggregated approach and reveal the reasons that lie behind the structural inflation problem. For that purpose, this study examines the price changes in six subcomponents of the CPI. These subcomponents are approximately composed %75 of the overall CPI. Also, by applying a disaggregated approach, this study demonstrates the importance of sectoral differences in pricing behaviors.

For that purpose, the scope of the thesis includes the analyses of different subcomponents of CPI by employing the ARDL model for a quarterly period that covers 2003Q1-2020Q1. Applying this model produces valuable results for both the short-run and long-run inflation dynamics.

1.2. Inflation History of the Turkish Economy

This subsection aims to present a view of Turkish inflation history based on a descriptive method. Figure 1.1 presents annual inflation rates in Turkey for the 1960-2019 period. The figure indicates the high inflation rates that the Turkish economy experienced before the 2000s. Then, the early 2000s witnessed a disinflation process in the economy. However, the Turkish economy refaces two-digit inflation rates in recent years.

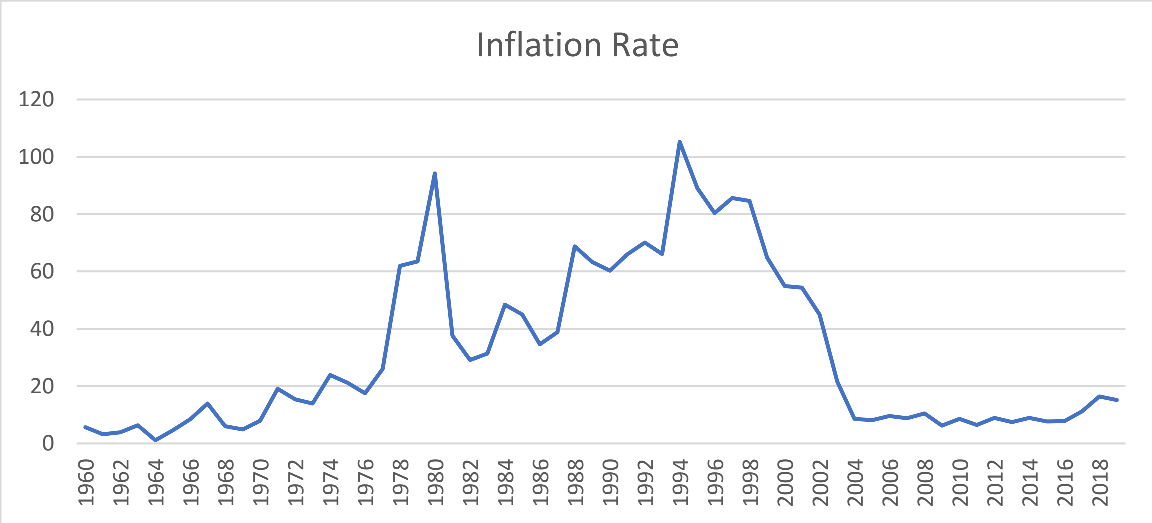

Figure 1.1. *Inflation Rate in Turkey between 1960 and 2019 (World Bank, 2020)*

1.2.1. Developments between 1980 and 2002

High inflation rates in the pre-2000s period are generally identified with the openness and liberalization experience of Turkey in the 1980s. The liberalization in the domestic economy begins with January-24 measures in 1980. These measures also liberalize and promote international trade. Figure 1.2 presents a sharp increase in international trade in the 1980s due to the openness process of the Turkish economy. However, because this liberalization and integration process accompanied several political instabilities and economic crises, the Turkish economy transformed into a more sensitive characteristic. Therefore, this transition period witnessed high levels of inflation rates until the early 2000s.

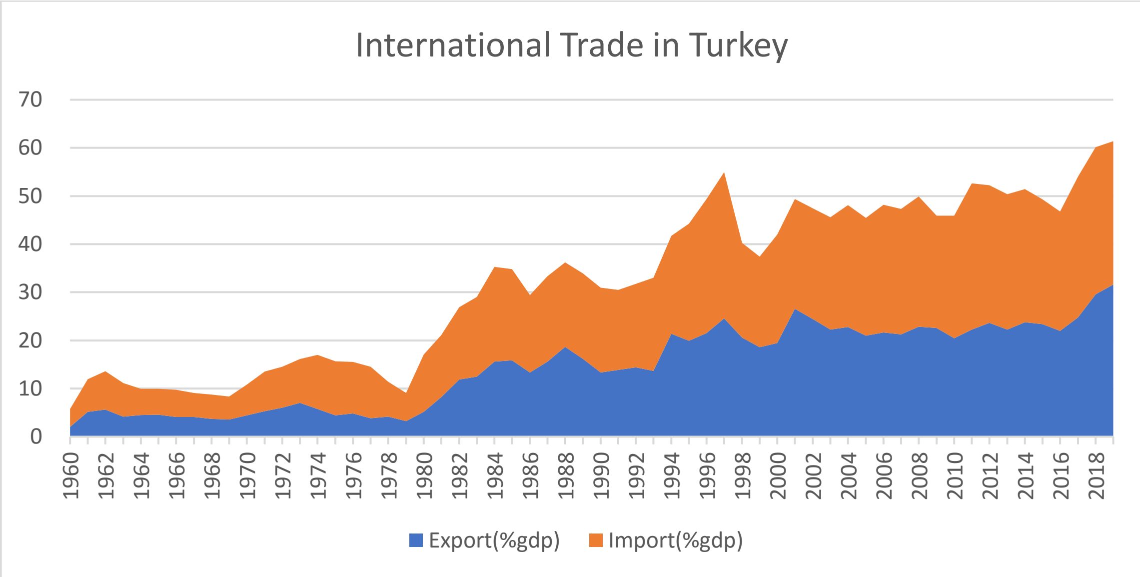

Figure 1.2. *Export and Import Share in Gross Domestic Product in Turkey between 1960 and 2019 (World Bank, 2020)*

After the high-inflation episodes in the 1990s, Turkey signed an agreement with the International Monetary Fund (IMF), including several structural reforms in 1999. This program aimed to reduce the inflation rate in the Turkish economy by pegging the exchange rate because the exchange rate was accepted as the most vital driver of the inflation rate. For that purpose, the Turkish economy switched to the fixed exchange rate regime, but this targeting did not give good results because pegging the exchange rate caused an overvaluation in the Turkish Lira. The rise in the value of the Turkish Lira increased the import volume of the economy since foreign goods became relatively cheaper for Turkish citizens. Also, for keeping the exchange rate constant, the Central Bank of the Republic of Turkey (CBRT) had to fund the market by using its exchange rate reserves, and hence it lost the dependency on domestic monetary policy. Moreover, most of the structural reforms in the IMF program did not fulfill in this period. In following, this environment deteriorated the confidence and expectations of economic agents. As a result of this process, the Turkish economy faced an economic crisis in November 2000. Figure 1.3 reveals the cost of this crisis. This month witnessed a considerable decrease in foreign exchange reserves of the CBRT. In contrast, the immediate increase in December 2000 presents the IMF credit that Turkey loaned (Uygur, 2001; Özatay and Sak, 2002).

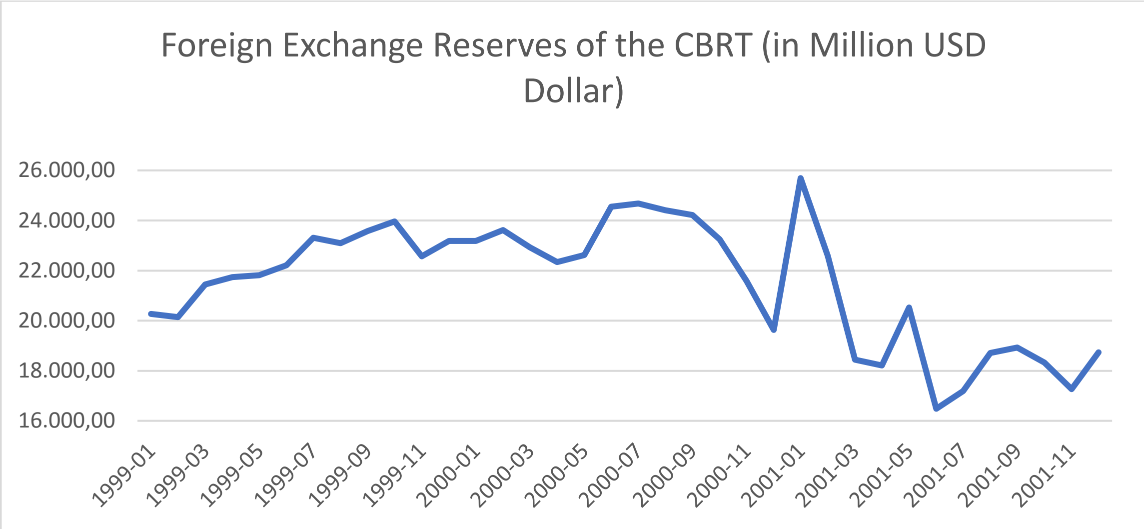

Figure 1.3. *Foreign Exchange Reserves of the CBRT (Electronic Data Delivery System (EDDS) of the CBRT, 2020)*

Since the cost of the November 2000 crisis was very high for the Turkish economy, the CBRT lost its power for fighting a new economic crisis. In this environment, the Turkish economy experienced the most significant economic crisis in February 2001. Even though the main reason for this crisis was the discussion between the president of the republic and the prime minister, this was just a spark. Just after the February 2001 crisis, Turkey switched to the floating exchange rate regime. Following this, the value of the Turkish Lira sharply decreased all year-round. Figure 1.4 indicates this sudden increase in the exchange rate in the US dollar in this period. This increase in the exchange rate means not only a decrease in the value of the Lira but also a rise in debts in foreign exchanges. Consequently, the everlasting economic instability, high inflation rates, and successive economic crises in November 2000 and February 2001 highlight the requirement for structural reforms in the Turkish economy.

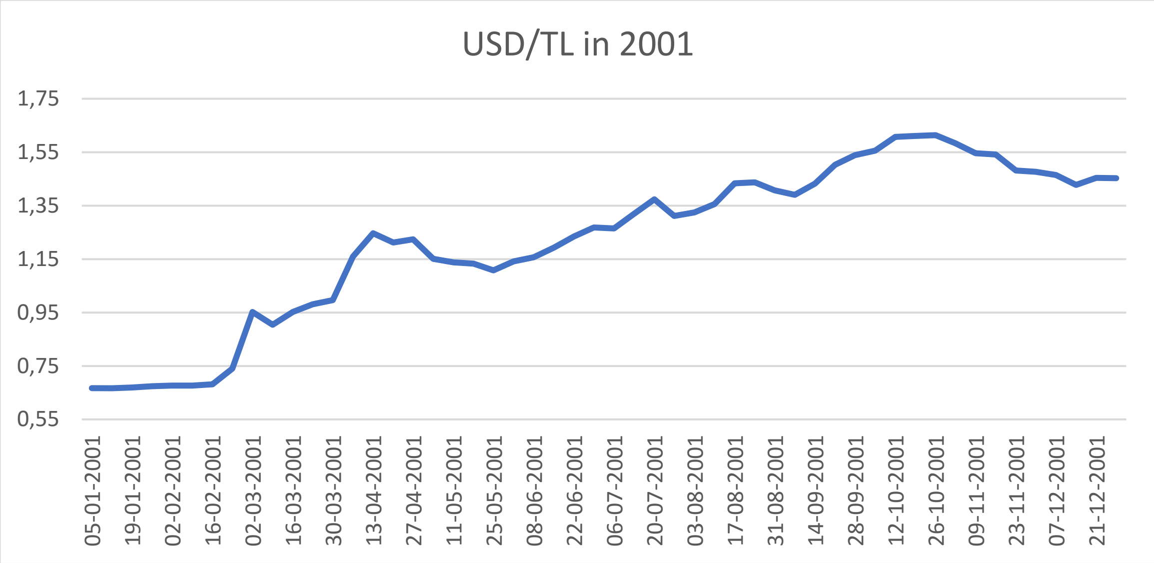

Figure 1.4. *USD/TL in 2001 (EDDS, 2020)*

1.2.2. Inflation targeting (IT) regime in Turkey

This subsection introduces the IT framework and the Turkish experience with it. After two economic crises, the Turkish economy began a recovery period with several reforms. As one of the most significant reforms, the law on the CBRT has changed. Before the regulation, one way of creating money for the CBRT was to create loans to the public sector. Following the successive economic crises, the law abolished this kind of money supply to annihilate one of the most significant sources of inflation and also guarantees the independence of the CBRT. In addition to these reforms, the election in 2002 ensured the political instability in Turkey. Most importantly, Turkey switched to the IT regime in monetary policy.

The main aim of the CBRT is to ensure price stability. For a better economic environment, the inflation rate should be as low as it annihilates uncertainty about future prices, but also it should be as high as it prevents recessions. The CBRT performs this aim under the IT regime since 2006.[1] IT regime refers to a policy that directly focuses on a numeric inflation target rather than using intermediate policies. Also, applying this regime necessitates several requirements, such as setting a numerical inflation target, a timetable to reach the target, independency about monetary policy, and accountability.

[1] Turkey switched to implicit IT regime in 2002. Switching to full IT regime occur in 2006.

Also, the inflation trend should be at low levels to apply the IT regime (CBRT, 2006; Belke and Polleit, 2009).

The primary policy tool of a central bank on reaching the inflation target is the nominal interest rates. Generally, central banks follow the Taylor Rule in setting the nominal interest rates. In theory, the Taylor Rule suggests a nominal interest rate that the central bank should set considering the inflation gap and the output gap:

$$i^* = \pi + r + \alpha(\pi - \pi^t) + (1 - \alpha)(y - y^*) \quad (1.1)$$

According to equation (1.1), the nominal interest rate, i^*, should be the sum of the inflation rate, π, an historical average of the real interest rate, r, the inflation gap, $(\pi - \pi^t)$, and the output gap, $(y - y^*)$. In this equation, π^t refers to the inflation target and y^* is the potential output. π and y are, respectively, the realized inflation rate and output. Also, α shows the relative importance of inflation and output target for the central bank. For instance, when $\alpha = 0.5$, the central bank equally focuses on both targets.

Moreover, the nominal interest rates affect prices through the monetary transmission mechanism. More clearly, the central bank sets the benchmark rate, and interest rates in the market follow the rate that the central bank determines. Then, for example, the increase in the interest rate depresses the output through different channels (Table 1.5). Furthermore, the decrease in demand also decreases the price level, p. Shortly the central bank controls the demand by using nominal interest rates, and change in the demand affects the inflation rate.

$$i \uparrow, y \downarrow, p \downarrow, \pi \downarrow$$

On the other hand, since the Turkish economy does not meet the related pre-requirements, it applies the implicit IT regime between 2002 and 2006. In this period, the monetary policy showed remarkable success in reducing the inflation rate. Besides, the victory in the inflation targeting is supported by the change in the law on the CBRT and several structural reforms. As Figure 1.6. indicates, the Turkish economy reached the inflation targets in the 2002-2005 periods[2].

[2] The CBRT targets the annual change of the year-end CPI as the inflation target.

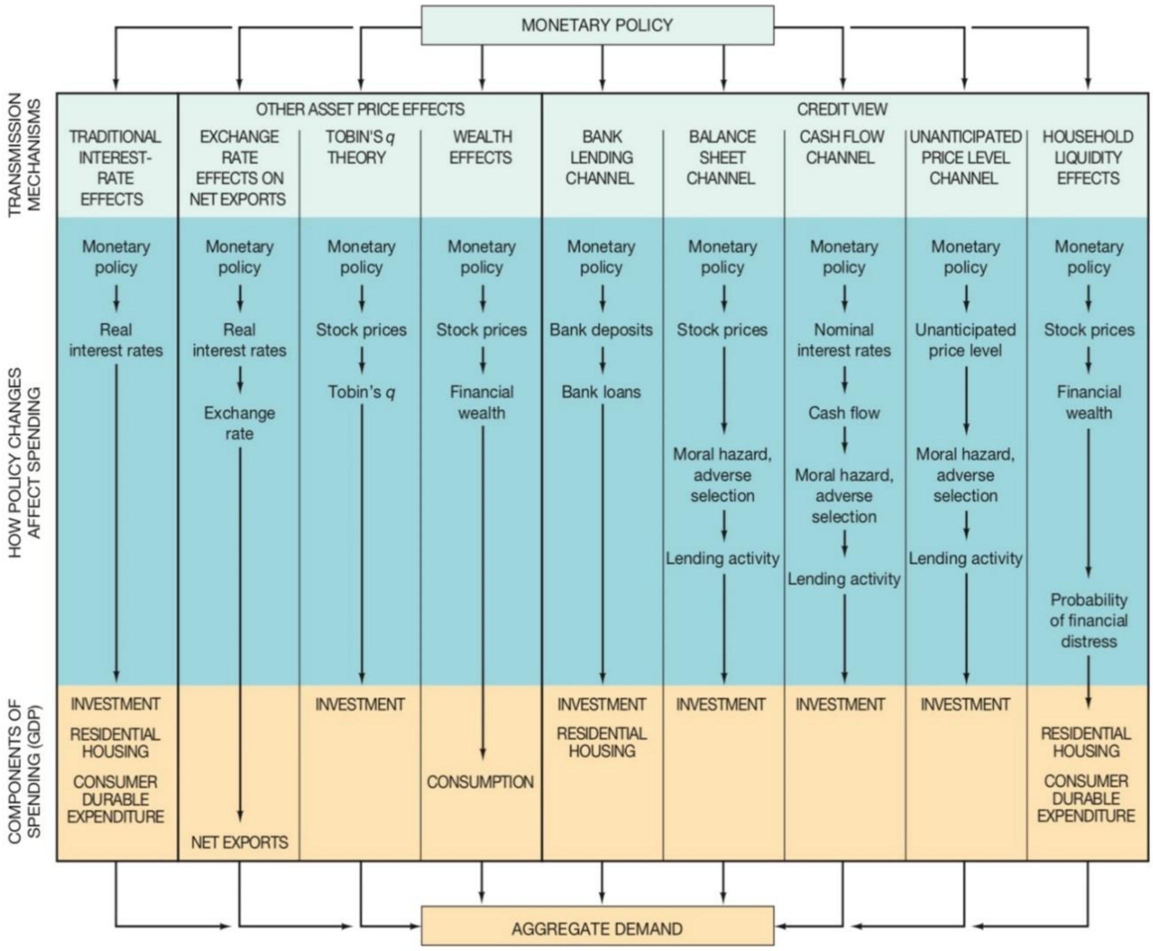

Figure 1.5. *Monetary Transmission Mechanism (Mishkin, 2019)*

Positive developments in this process increased the robustness of the economy and ensured economic stability. Many studies, including Arslaner et al. (2014) and Kara and Öğünç (2014), imply that the exchange rate pass-through effect in pricing significantly decreases in this period. Since the Turkish economy provides a reliable economic environment and fulfills the pre-requirements for the IT regime in this period, it switched to an explicit IT regime in 2006. In the following years, the Turkish economy suffered from several shocks, such as one of the biggest crises that the world economy faced in 2008, and political and social concerns on domestic issues.

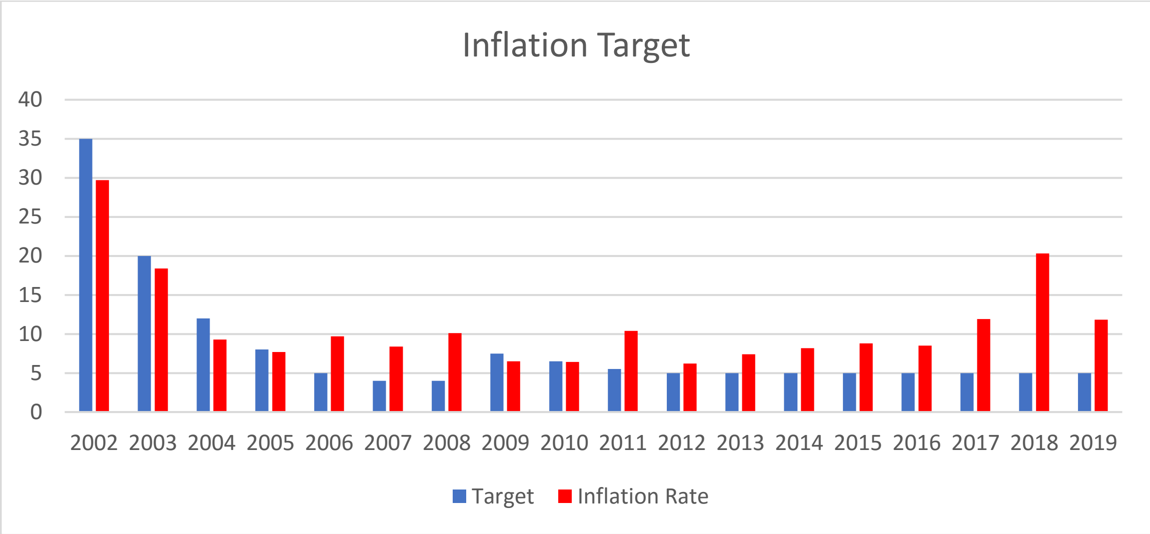

Figure 1.6. *Inflation Targets and Realized Inflation Rate in Turkey Between 2002 and 2019 (EDDS, 2020)*

1.2.3. Analysis of the recent inflation dynamics in Turkey

The Turkish economy showed a significant success between 2002 and 2006 by reducing the inflation rate and enhancing the expectations of economic agents. After this transition period, several domestic and foreign factors have affected the inflation rate in Turkey. The first shock was the Global Financial Crisis of 2008 (GFC) that arise in the US and spread into the world. In the pre-crisis period, the inflation trend in the global economy was very high because of the demand pressures. The inflation rate in Turkey followed this trend and overshot the target in 2006 and 2007. However, the world economy experienced the most substantial economic crisis of the last century in 2008. Following this crisis, the global economy dramatically shrank, and prices sharply fell. In parallel with these developments, weakness in demand creates a negative output gap in Turkey, and the inflation rate was realized under the target in 2009[3] (Figure 1.6-1.8).

[3] In Figure 1.8, while the blue line shows the GDP level in Turkey in expenditure approach (in billion), the straight red line is the trend of the GDP. The difference between these two lines shows the *output gap*. Due to the law of demand, the positive output gap creates an upward pressure on prices. On the other hand, the lack of demand is accompanied by falling in prices.

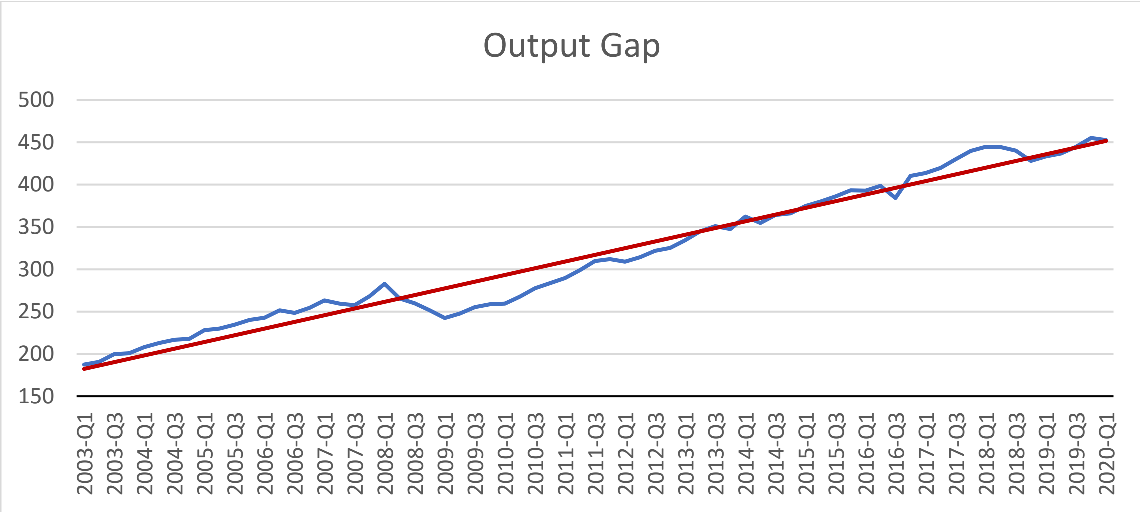

Figure 1.7. *Seasonally Adjusted Gross Domestic Product by Expenditure Approach (in Billion TL) with the Trend Line in Turkey between 2003Q1-2020Q1 (EDDS, 2020)*

On the other hand, the crisis that arises in the financial system implies that price stability is not enough to ensure economic stability as long as it is not supported by financial stability. This view changes the monetary policy perspective in all around the world. Many central banks employed modern monetary policies such as quantitative easing and macro-prudential policies that seek the stability of the financial system. Following this change, the Turkish economy also started to care about financial stability alongside price stability. However, the existence of these policies was weird because the appropriate interest rates for both stabilities are not the same. For example, an increase in the interest rates may drop the inflation rate through demand, but it may also cause speculative attacks in the international funds market due to the high return. To prevent this, the CBRT has used alternative policies such as the corridor system to expand the range of interest rates and the mechanism of the required reserve ratio to control the credit market. However, even though the CBRT applies these kinds of policies, its ultimate target has remained as the price stability (Başçı and Kara, 2011; Üçer, 2011).

Besides, many central banks such as the FED, ECB, and BOE applied quantitative easing and created funds for the global financial market to rump up economic growth in the post-crisis period. A significant part of these funds flowed to the emerging economies, including Turkey, partially recovered economic growth rates. However, concerns about the world economy limited these flows due to the deterioration of the risk appetite of investors. Therefore, inflation dynamics in Turkey showed a fluctuating course in this period.

Furthermore, Figure 1.8 indicates the changes in the Consumer and Producer Price Indexes (CPI and PPI) after 2003. The exchange rate fluctuations have played a crucial role in these prices in recent years. The foreign exchange rate in the Turkish Lira started to an increasing trend after the GFC with a decrease in risk appetite due to concern about the world economy. The exchange rate in dollars crossed the line of 2 TL in 2014 by the effect of domestic developments in 2013, such as the Gezi Park Protests and the 17-25 December process. On the other hand, even though the Turkish Lira devalued in this process, the pass-through effect remained limited, depending on the decreasing trend in oil prices between 2012-2016 (Figure 1.11).

Domestic developments, such as the coup attempt in 2016 and the declaration of the state of emergency, increase the risk premium of the Turkish economy. Besides, the US elections that caused a shift in funds from emerging economies to developed economies negatively affect the exchange rate. For these reasons, the depreciation process in the Turkish Lira continued in 2016. Continuous rise in the exchange rate and consecutive domestic shocks after 2013 deteriorated the confidence and expectations of economic agents and led to a downfall in the capital inflow to Turkey. These developments also influenced the pricing behaviors of economic agents and rose the indexation on the exchange rate and previous prices. On the other hand, state-funded loans supported economic growth in 2017, and the Turkish economy reached the highest growth rate in its recent history (Figure 1.8).

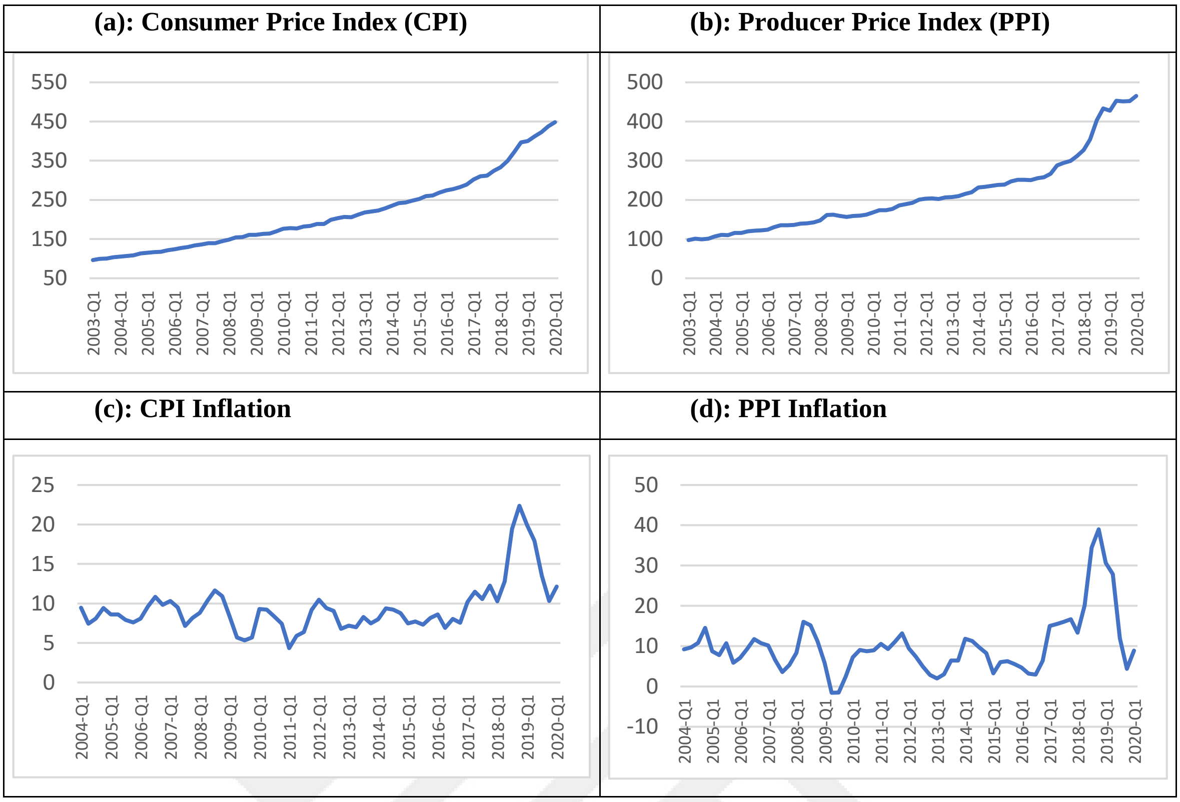

Figure 1.8. *Changes in the Consumer and Producer Price Index in Turkey between 2003-2019 (EDDS, 2020)*

However, since the rise in consumption and the construction sector drives this growth, it could not be sustainable, and the supply-side shocks remained over in the economy. The increasing rate in the exchange rate dramatically raised due to the political relationships with the US and the sanctions in August 2018 (Figure 1.9). While the Turkish economy experienced the highest economic growth rate of the 21st century in 2017, it is followed by the highest inflation rate of recent history in 2018. These consecutive indicators give rise to the thought that a positive output gap triggers an increase in the inflation rate. After this shock, even though the exchange rate began to decline due to the contractionary policy responses of the CBRT, it reached and passed the August 2018-level in early 2020. Finally, the process between 2013 and 2020 confirms that the Turkish economy went round in a circle that the exchange rate and deterioration in expectations affect each other, and they jointly affect the pricing behaviors.

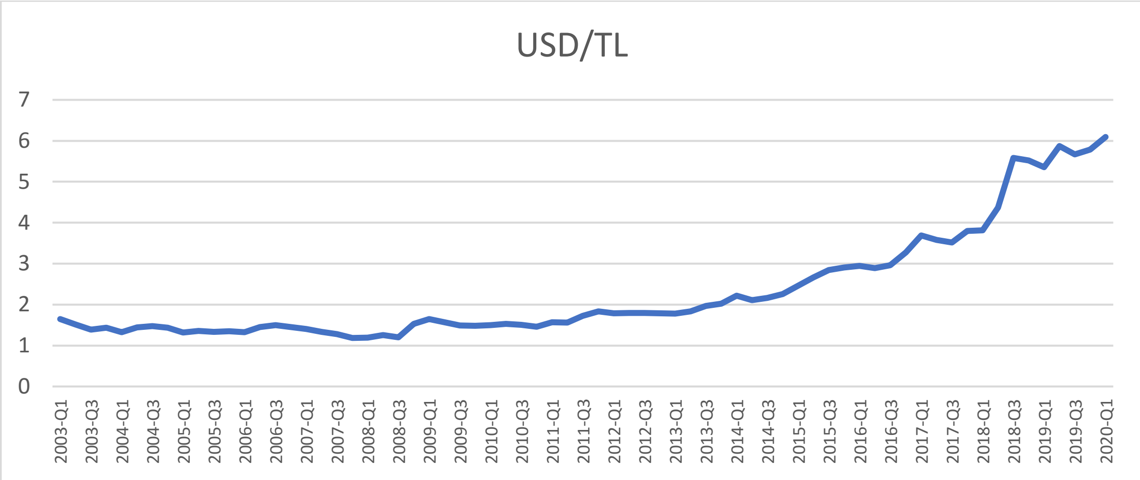

Figure 1.9. *USD/TL between 2003-2020 (EDDS, 2020)*

On the other hand, there are several reasons why the exchange rate is quite crucial in price setting in Turkey. The main reason for this issue is Turkey's dependence on foreign sources that manifests itself on international trade. Since Turkey is an importer country, changes in foreign exchange rates significantly affect the inflation rate in different channels. Firstly, an increase in the exchange rate directly affects the prices of imported final consumption goods. Also, about %75 of the import volume of Turkey is composed of intermediate goods that the firms use in production processes (Figure 1.10). Therefore, an increase in exchange rates severely affects production costs, which indirectly reflects the prices of goods and services (Yüncüler et al. 2018).

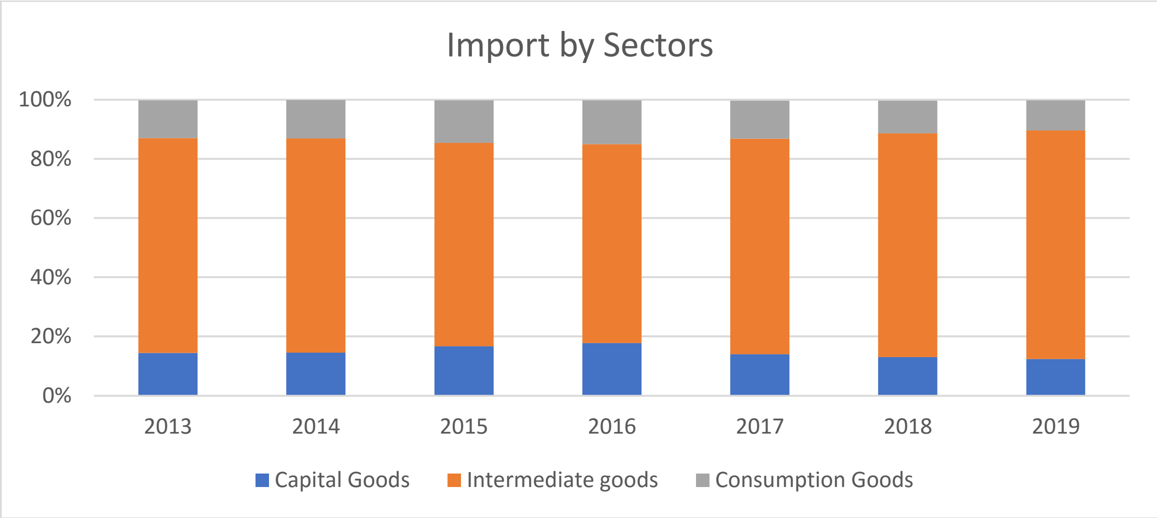

Figure 1.10. *Import by Sectors in Turkey between 2013-2019 (Turkish Statistical Institute (TSI), 2020)*

Moreover, energy prices are also a critical driver of inflation since many sectors use imported energy (Ertuğ and Özmen, 2020). Energy prices affect the inflation rate due to changes in the exchange rate rather than its prices, as Figure 1.11 explains. The blue line in the figure shows the oil prices in terms of the US Dollar. In 2003 oil prices were 28.85 in dollar and 54.4 in Turkish Lira. Oil prices in the dollar raised to 64.3 in 2019. However, this level corresponded to 364 Turkish Lira in this year.

So, the exchange rate not only directly affect the prices through final consumption goods, but also indirectly affect it through production costs. In addition to this channel, the continuous instability in the exchange rate also influences the pricing behaviors through the expectation channel because the continual increasing trend in the exchange rate leads to price-setters to raise the prices higher than the increase in the exchange rate.

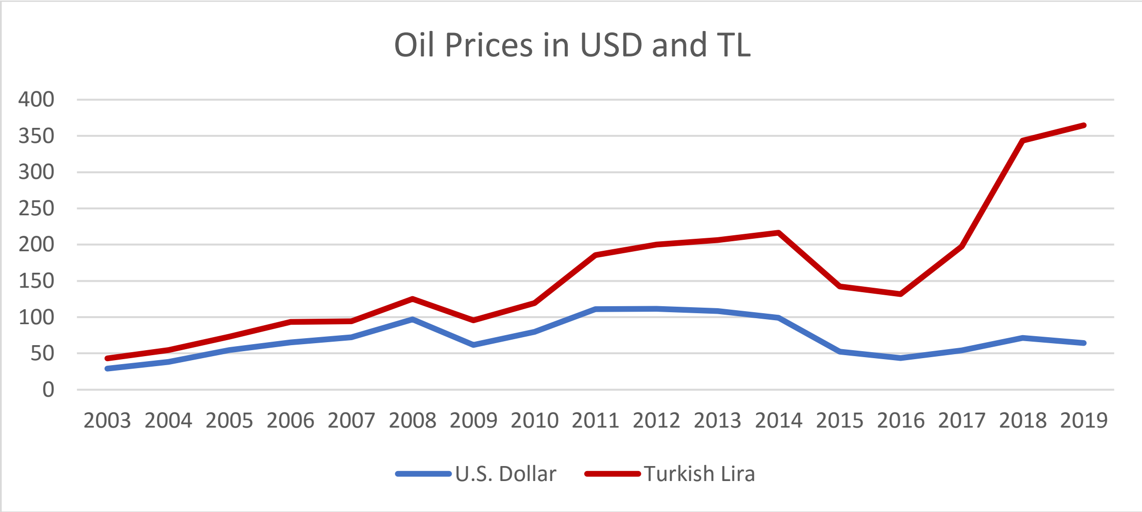

Figure 1.11. *Europe Brent Oil Prices in terms of United States Dollar and Turkish Lira (US Energy Information Administration, 2020, and Author's Calculation)*

In summary, this subsection reveals that the Turkish economy has a chronic inflation problem and the primary source of this is the dependence on foreign sources. This dependency makes prices very sensitive to changes in the exchange rate, and thus, expectations are formed based on exchange rate dynamics. Therefore, both domestic and foreign shocks separately push up the inflation rate through the exchange rate. Also, even though the data reveal that the negative and positive output gaps respectively create downward and upward pressure on prices, the effects of cost dynamics dominated the demand pressure on inflation. Consequently, this subsection expresses that the crucial determinants of inflation in the Turkish economy are the exchange rate, energy prices, and imported goods and services.

2. THEORETICAL BACKGROUND

Phillips curve has been about 60 years of historical background from the famous work of Phillips (1958) to today. Although the Phillips himself named the curve, neither Phillips gave this name to it nor was this the first article which analyses inflation dynamics.

This section presents a historical background of the PC in four different subsections. The first subsection focuses on Phillips' (1958); however, it also includes the developments before Phillips' study and in just after 1958 about the PC concept.

The second subsection includes the improvements which arose under the natural rate and rational expectations hypotheses in the late 1960s and early 1970s. In the following, the third subsection deals with the modern form PC. Moreover, the fourth subsection deals with how the New Keynesian Phillips curve (NKPC) built in the 1980s and 1990s, was born.

2.1. Traditional Phillips Curve

This study mostly discusses concepts such as inflation, unemployment, and economic growth (or output). All these concepts are the keystones of macroeconomics. Therefore, an outstanding macroeconomic analysis necessitates a detailed examination of these concepts. British economist John Maynard Keynes (1883-1946), who is accepted the father of macroeconomics study, started these kinds of economic analyses.

Before Keynes, the classical economists were assuming an economy that is always in equilibrium thanks to an invisible hand that provides this absolute equilibrium due to the self-interest of economic agents. So, because of a vertical supply curve caused by flexible prices, the economy always keeps the equilibrium level of output and unemployment while prices change. In such a case, there is no trade-off between inflation and unemployment since flexible prices are unrelated to the output. However, the Great Depression (1929) caused the downfall of classical economics and rising Keynesian economics. In contrast, Keynes proposed that the source of economic fluctuations was movements in demand rather than supply and the reason for the depression is inadequate demand. In other words, Keynes emphasized that the economy is not in equilibrium in the short-run, and changes in demand can affect prices.

Likewise, Phillips' (1958) study is also in the framework of Keynesian economics. Phillips (1958) tests the hypothesis that if the movements in unemployment rate explain changes in the rate of change of money wage rates in the United Kingdom (UK). To test this hypothesis, Phillips divided his data into three parts as 1861-1913, 1913-1948, and 1948-1957. This disaggregation was sensible because the second period (1913-1948) includes unusual events such as World War I and II and the Great Depression.

The results for the first and third period support the hypothesis and presents a non-linear relationship between the variables. More clearly, when unemployment is at low levels, the change in wage rates is very high. On the contrary, when unemployment is high, the change in wage rates is very low. The following equation show represents this non-linear relationship:

$$w_t = f(U_{t-1}) \tag{2.1}$$

where $\frac{\partial f}{\partial U_{t-1}} < 0$, w indicates the nominal wage growth and U_{t-1} is the unemployment rate in the previous period.

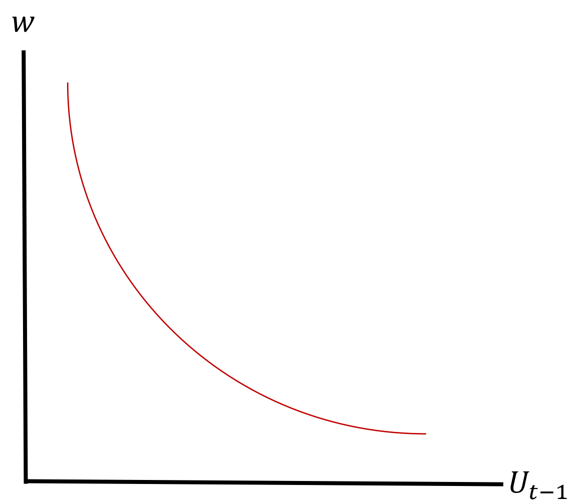

Figure 2.1. *Traditional Phillips Curve*

On the other hand, even though many economists accept that Phillips (1958) is the starting point of inflation-unemployment trade-off analysis, Fisher (1926) had analyzed the relationship between unemployment and changes in prices before Phillips. According to Fisher, in an economy with rising prices, profits also rise since income rises. Besides, since expenses are fixed because of contracts, an increase in the price level causes a climb in employment through increasing profits. The most significant difference between Fisher (1926) and Phillips (1958) is the causality between variables. As in the example, Fisher observes a causality from prices to employment while Phillips observes a causality from employment to prices.

Although there were articles about economic variables like inflation and unemployment before 1958, Phillips (1958) is recognized as the beginning of a new way in economics. This new way is initiated by Phillips and named by Samuelson and Solow (1960). In contrast to Phillips, the sample of this study was the United States (US), and their key variables were the rise in average price level and unemployment rate. In this study, they assume that firms set prices based on the following mark-up formula: (Belke and Polleit, 2009; 390-393)

$$P_t = (1+\psi)\frac{L_t}{Y_t}W_t \tag{2.2}$$

In equation (2.2), $\frac{L_t}{Y_t}W_t$ shows the wage costs for a firm. L refers to the labor, Y indicates the output level, and W presents the nominal wage. Also, ψ is the profit mark-up of a firm. In short, the equation shows the pricing behavior of a firm based on the wage cost. Also, the relationship between labor productivity and the real wage is presented as:

$$\frac{1}{(1+\psi)}\frac{Y_t}{L_t} = \frac{W_t}{P_t} \tag{2.3}$$

Furthermore, assuming that the change in labor productivity corresponds to a proportional change in real wages yield the following equality:

$$\Delta ln\left(\frac{Y_t}{L_t}\right) = \Delta\, ln\left(\frac{W_t}{P_t}\right) \tag{2.4}$$

After rearranging equation (2.4), the nominal wage growth can be written as:

$$w_t = \pi_t + \lambda \tag{2.5}$$

where π_t refers percentage change in the price level ($\Delta\, ln\, P_t$), the inflation rate and λ is a constant that represents the labor productivity.

By using equations (2.5) and (2.1), the PC in terms of inflation is:

$$\pi_t = f(U_{t-1}) - \lambda \quad (2.6)$$

In equation (2.6), the inflation rate is a negative function of the unemployment rate in the previous period. Also, λ indicates that the decrease in labor productivity accompanies a rise in the prices. Also, changes in the unemployment rate define the slope of the PC, while λ causes upward and downward shifts in the curve.

Samuelson and Solow (1960) named the curve representing the negative relationship between the price level and unemployment as "*Modified Phillips Curve*". Figure 2.2 illustrates the original curve in Samuelson and Solow (1960). After Phillips (1958) and Samuelson and Solow (1960), this curve is universally used to explain the trade-off between inflation and unemployment.

Inarguably, all these cited articles are quite cherished, and each of them has notable contributions to literature. However, the matter in hand is related to an era that is not like today in many aspects. The world that these early articles considered is the one with the World Wars, limited international trade, and no modern technology. However, today's world is considerably different. Therefore, these articles can only be a great theoretical background to analyze the modern world. Accordingly, economists after Phillips have improved this theoretical framework.

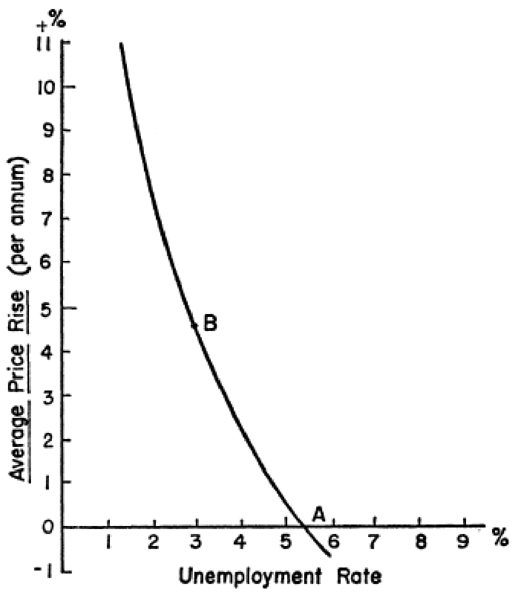

Figure 2.2. *Modified Phillips Curve (Samuelson and Solow, 1960)*

2.2. Natural Rate Hypothesis, Rational Expectations, and Phillips Curve

This subsection includes the developments in the PC in the late 1960s and early 1970s. The most influential actors of this era are M. Friedman, E.S. Phelps, and R.E. Lucas. While Friedman and Phelps mostly identify with their *natural rate hypothesis* approach to PC, Lucas gained a reputation with his *rational expectations* approach and *Lucas aggregate supply curve*.

In his influential contribution, Friedman (1968) discusses the abilities of monetary policymakers. According to Friedman, monetary policy cannot peg the real interest rate and employment; it can only control nominal variables. However, monetary policy may only have some effects on real variables. In this respect, as a starting point of the analysis, Friedman criticizes Phillips to distinguish nominal and real variables. Friedman explains his view with an example. In the example, the monetary authority conducts an expansionary policy to reduce unemployment by decreasing interest rates. Falling interest rates raise the expenditure and growing in demand increases the price level. Then, firms hire more employees to boost production. This process reduces unemployment and improves nominal wages. For Friedman, this is only the beginning of the whole process. As firms are smarter than the public, and they have better information about the market, firms increase nominal wages less than the rise in prices. So, the real wage that workers receive decreases. After a while, workers form their behaviors, and their awareness affects the labor market by an increase in real wages. As a result of this, employment goes back to its initial level, called *the natural level of employment*. This level refers to an employment level that corresponds to the long-run level of output and which does not accelerate inflation. For that reason, this natural level is also called the *"non-accelerating inflation rate of unemployment (NAIRU)"*. So, this example brings us to the conclusion that there is only a short-run trade-off between inflation and unemployment, and this trade-off is not valid for the long-run. (Friedman, 1968; 7-11).

In addition to this, Phelps (1968) explains the relationship between inflation and unemployment with money illusion. Money illusion refers to a case that economic agents do not realize the difference between nominal and real variables. For example, when nominal wages increase, the workers may feel better, even though their real income does not increase. This imperfection decreases the unemployment level and produces a negatively-sloped short-run PC (Figure 2.3). Also, the illusion is due to imperfect information in the short run. However, economic agents have relatively improved information about the market, and they are smarter in the long run. Accordingly, this concludes with a horizontal PC at a natural level of unemployment without money illusion.

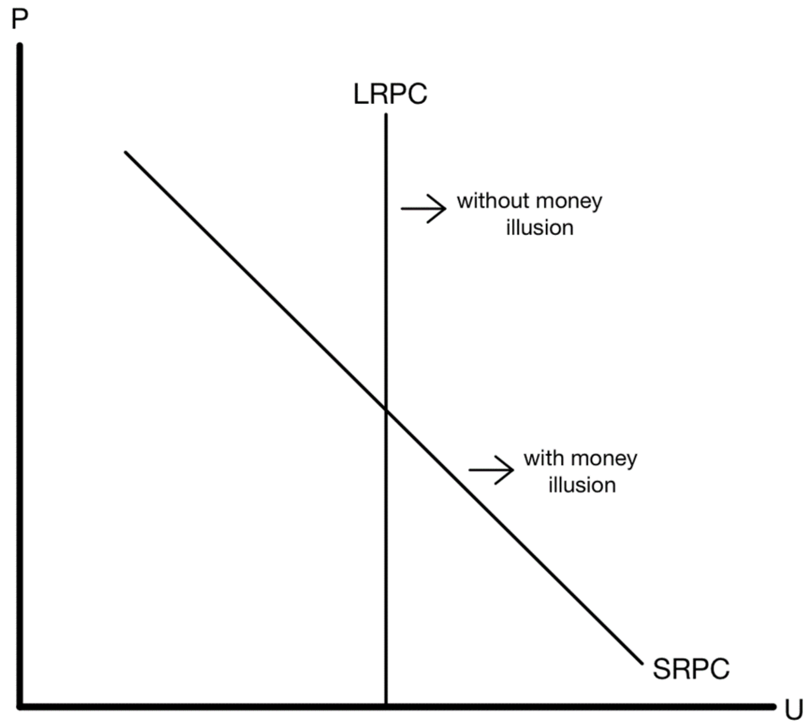

Figure 2.3. *Short-run and Long-run Phillips Curves and the Money Illusion*

In addition to these, the mathematical form of the PC that the Friedman-Phelps framework suggests is:

$$\pi = \pi^e - \alpha(u - u^n) \tag{2.7}$$

where π^e represents expected inflation and $(u - u^n)$ is the difference between the unemployment rate and the natural rate of unemployment, the *unemployment gap*. If the u is below u^n, this creates a negative unemployment gap and triggers a rise in the inflation rate. Also, α shows the sensitivity of the inflation rate to this gap and determines the slope of the PC. Moreover, since π^e exists, equation (2.7) is called as the *expectations-augmented Phillips curve*. Also, unlike equation (2.6), (2.7) shows the negative relationship between the inflation rate and the unemployment gap in the short run. Moreover, because unemployment reaches the natural level in time, the difference between u and u^n equals to zero in the long run. In other words, the trade-off between inflation and unemployment disappears in the long run.

Furthermore, a straightforward assumption makes the equation (2.7) more convenient to explain the concept of NAIRU. Assuming that inflation expectations in equation (2.7) are formed in a backward-looking manner yields the following equation:

$$\pi = \pi_{t-1} - \alpha(u - u^n) \quad (2.8)$$

where $\pi_{t-1} = \pi^e$. After subtracting π_{t-1} from both sides of the equation (2.8), change in inflation rate is:

$$\Delta\pi = -\alpha(u - u^n) \quad (2.9)$$

In equation (2.9), a negative unemployment gap raises the change in the inflation rate. In other words, it accelerates the inflation rate. In contrast, when $u = u^n$, the inflation rate does not accelerate. That is why u^n is called as the non-accelerating inflation rate of unemployment.

In addition to the natural rate hypothesis, Lucas (1972, 1973) improved the Friedman-Phelps framework by adding one more assumption: rational expectations. Lucas neglects all forms of money illusion. He emphasizes that economic agents use all available information rationally in the existence of rational expectations. However, it does not mean that they never make a mistake. For that reason, even though all expectations are rational, there are still some imperfections in Lucas' world. Therefore, Lucas suggests that any monetary policy that wants to affect the economy must be unanticipated. More precisely, only a policy that is different from existing expectations can affect the output. In other words, monetary policymakers must shock the economy to affect real variables, particularly output. Hence, the anticipated policy does not affect output.[4]

On the other hand, as an essential point, Lucas developed a model that shows the relationship between inflation and output. He argues the existence of a positive relationship between the price level and production. Lucas points out suppliers'

[4] This case is known as the policy ineffectiveness proposition and this concept is generally attributed to Sargent and Wallace (1975)

misinterpretation between general price movements and relative price changes. Accordingly, in a situation that producers do not recognize the general price level increase in the economy, each of them thinks that the relative price of their product increase and they raise the production. This is, in fact, a case that price level is higher than the expected price level. To sum up, this discrepancy between the actual price level and expected price level accompanies a gap between the potential and actual level of output. The Lucas Aggregate Supply Curve represents this relationship:

$$\pi - \pi^e = \beta(y - y^*) \qquad (2.10)$$

where $(y - y^*)$ is the difference between the output growth and its potential level, the *output gap*. In equation (2.10), a positive deviation from the potential output growth causes an inflation rate higher than the expected inflation. In other words, equation (2.10) is an aggregate supply equation that shows the positive link between output and prices.

2.3. Modern Phillips Curve

Phillips curve, which illustrates the inverse relationship between inflation and unemployment, gained popularity in the 1960s. However, this negative relationship disappeared in the 1970s when inflation and unemployment simultaneously increased due to several oil shocks. This period changed the perspective on the PC, and theorists add one more variable to the PC equation: (Gordon, 1977 and Mishkin, 2015; 285-294)

$$\pi = \pi_{t-1} - \alpha(u - u^n) + p \qquad (2.11)$$

In equation (2.11), p represents the effects of supply shocks that increase the cost of production. In other words, some changes such as a rise in input prices, a decrease in productivity, or any other supply shock create upward pressure in the inflation rate.

On the other hand, the relationship between equations (2.10) and (2.11) produces a more convenient inflation equation. This relationship can be originated by using the following Okun's Law:

$$u - u^n = \phi(y - y^*) \qquad (2.12)$$

where $\phi < 0$, and it shows the responsiveness of the unemployment gap to movements in the output gap. In other words, equation (2.12) indicates the negative connection between the output gap and the unemployment gap. This relationship is inverse because when the output positively deviates from its potential level, the unemployment rate realizes under the u^n.

Using the equation (2.12) to substitute $(u - u^n)$ in the equation (2.10) yields the following equation:

$$\pi = \pi_{t-1} + \lambda(y - y^*) + p \qquad (2.13)$$

where $\lambda = -\alpha\beta$. Equation (2.13) is the short-run aggregate supply curve, and it is quite similar to the equation (2.10). Also, equation (2.13) is the *Modern Phillips curve* that the output gap replaces the unemployment gap. Figure 2.4 presents the relationship among the Phillips curve, Okun's Law, and aggregate supply curve. These figures summarize how the inverse relationship in equation (2.11) turns into positive in equation (2.13). Furthermore, the modern PC in equation (2.13) is also known as the triangular PC since it contains three drivers for the inflation: inflation expectations, the output gap, and supply shocks.

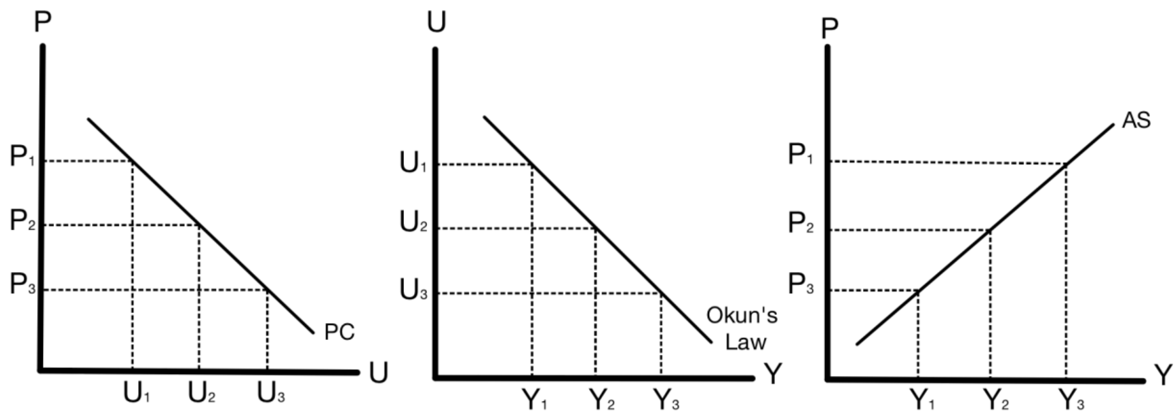

Figure 2.4. *Phillips Curve and Aggregate Supply Curves*

Inflation expectations may refer to any event that affects the pricing behaviors of firms. Change in inflation expectations initiates upward or downward shifts in the PC, and it does not affect the slope of the curve. Also, in equation (2.13), inflation expectations are sticky. More clearly, economic agents form their inflation expectations based on the inflation rate in the previous period (π_{t-1}). This assumption is sensible because firms consider the inflation trend in previous periods when setting new prices.

For instance, if the inflation trend is high in recent years, firms assume that this increasing trend persists. So, it affects their pricing behaviors, and they index prices in a backward-looking manner. In general, the environment in the economy and prospects about the macroeconomic variables determines the inflation expectations.

On the other hand, change in the output gap ($y - y^*$) affect the inflation rate in the short run. An output growth that is higher than the long-run potential level, y^*, creates upward pressure on the inflation rate. This type of inflation is called demand-pull inflation since the pressure comes from the components of the output.[5] Figure 2.5 explains the process that produces demand-pull inflation. To understand better, suppose that the government conducts an expansionary policy and reduces the taxes to reach the output target, Y^T. This tax cut increases the output level through demand. Then, the AD curve shifts to AD_1. In point 2', the output is higher than its potential level. According to equation (2.13), this positive output gap creates upward pressure on inflation, and the AS curve also shifts up. In the new equilibrium level of 2, the output turns back on its potential. However, the inflation rate is higher than the initial level. After this process, the government may pursue the output target to affect the public in the short run. This goal initiates a shift from AD' to AD''. The new output gap also shifts the AS' curve up, and the economy moves the long-run equilibrium. In point 3, the output is at the potential level. Because the long-run aggregate supply curve (LRAS) depends on variables such as labor, capital, and the level of technology, changes in demand affect the output only in the short-run. On the other hand, the higher inflation rate in the long-run remains as the cost of the expansionary policies that pursue short-run growth.

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[5] This pressure comes from the component of the aggregate demand such as consumption, investment, government purchases and export.

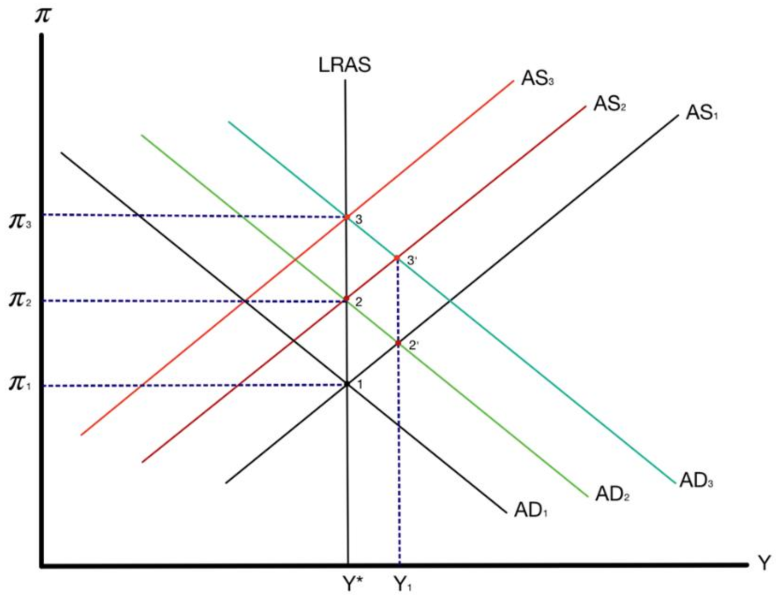

Figure 2.5. *Demand-Pull Inflation*

The third component of the modern PC is the cost shocks. Figure 2.6 indicates the process of cost-push inflation. Suppose that oil prices increase due to the political uncertainties in the world. Since oil is a crucial input for production, the increase in oil prices acts as a negative supply shock arising from an increase in the cost of production. Then, the aggregate supply curve shifts from AS to AS' In point to 2', the output is below its potential. In this case, the negative output gap causes the economy to return its initial level (Equation 2.13). However, if the policymakers would like to respond to this negative output gap with an expansionary policy, this shifts the AD curve to AD'. The output returns to the potential level with a higher inflation rate in point 2. Also, if the rise in the cost of production continues and policymakers pursue the expansionary policies to respond to these shocks, the economy respectively moves to point 3' and 3. In this scenario, activist policy responses raise the inflation rate, while the output remains unchanged in the long run. The process of cost-push inflation is quite similar to demand-pull inflation. However, cost-shocks is more severe because it deteriorates both inflation and output.

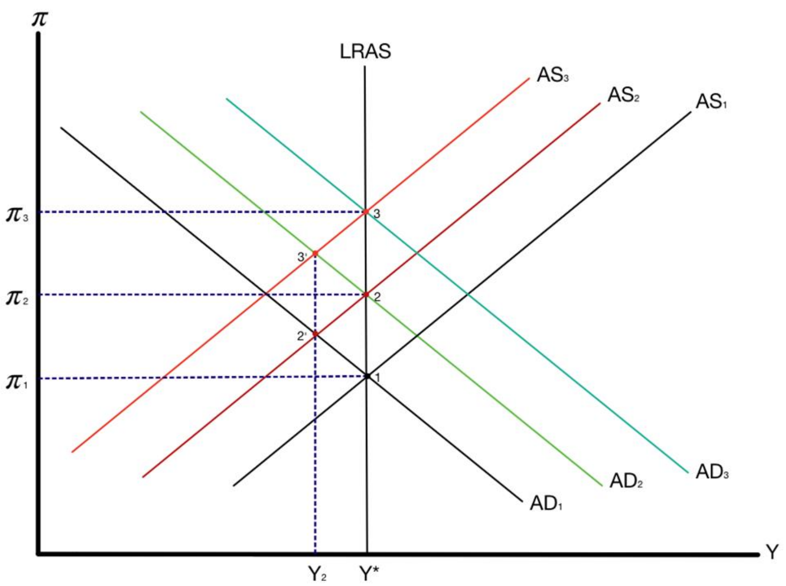

Figure 2.6. *Cost-Push Inflation*

In brief, Phillips (1958) discovers a non-linear inverse relationship between change in money wage rates and unemployment in the UK. Then, Samuelson and Solow (1960) transform it as a relationship between inflation and unemployment. Afterward, the Friedman-Phelps framework draws attention to the importance of the long-run natural level in PC analysis. Furthermore, failures of the traditional PC in the 1970s alters the outlook on the inflation-unemployment relationship and reveals the importance of the supply shocks on inflation dynamics. These developments raise the popularity of the modern PC that highlights three variables that drive inflation: inertia, demand, and supply.

2.4. New Keynesian Phillips Curve

2.4.1. Closed-economy New Keynesian Phillips Curve

One of the essential characteristics of the PC literature in the 1970s, especially Lucas (1972, 1973), was microeconomic foundations. Indeed, the NKPC was also built on a microeconomic basis. Traditional Keynesian economics stated that markets are not perfectly competitive, and prices are sticky rather than flexible as classical economists had assumed. In this respect, New Keynesian Economics aims to explain the reasons that lie behind sticky prices. (Gordon, 1990; p:1116). Therefore, building NKPC begins with models that explain price and wage stickiness. These models are generally contracting models that consider fixed wages and prices, and they commonly associate with staggered adjustment of prices.

Models about staggered price setting are divided into two different parts, which are time-dependent and state-dependent models.[6] Time-dependent models assume that firms set prices in different periods in a fixed probability. On the other hand, price setting decision is based on market dynamics in state-dependent models, and menu costs are accepted as the source of price stickiness. If the gain from price adjustment is higher than the menu cost arising from changing prices, firms change prices. (Bari 2013, 14-22).

As an example of these kinds of models, Fisher (1977) analysis the effectiveness of monetary policy in the existence of long-term contracts and rational expectations. Fisher points out that monetary policy can only affect output when wage contracts are fixed for the long-term. This is because the monetary authorities have better information than economic agents and know about wages contracts in the economy, as Friedman and Phelps emphasize. Also, Taylor (1980) studies staggered contracts. Here, staggered means that contracts of different periods are related to each other. In other words, today's contract is influenced by the contracts which are previously made and the contracts which are expected to be made in the future. Hence, where firms in the Fisher model independently made contracts for each period, contracts in the Taylor model are related to past and expected future contracts. Thus, according to Taylor's staggered contracts model, the effect of monetary policy goes on for a long time because of the persistence of wages. Also, Rotemberg (1982) solves a firm's cost minimization problem subject to price and emphasizes that firms set their prices based on this problem. Moreover, Calvo (1983) produces a model that is frequently utilized to derive the NKPC. In this model, each firm considers the prices set by other firms and waits for a signal to change their prices.[7]

Calvo (1983) separates firms based on their price-setting decisions. For these firms, where the probability of changing prices is $1-\theta$, keeping prices constant is θ. Firms that can change prices set the desired price, p^*. Besides, if a firm is not able to set the

[6] The most popular state-dependent models are Dotsey, King and Wolman (DKW) model and Golosov and Lucas model which are respectively developed by Dotsey etc. (1999), and Golosov and Lucas (2007).
[7] Roberts (1995) presents detailed derivations of the NKPC based on these models.

desired price, it follows the previous period's prices, p_{t-1}. Then the aggregate price level is

$$p_t = \theta p_{t-1} + (1-\theta)p_t^* \tag{2.14}$$

Assuming that firms consider nominal marginal cost, mc_t^n, in the price-setting decision, and β determines the degree of infinite relationship between the nominal marginal cost and desired price, the desired price level is

$$p_t^* = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\{mc_{t+k}^n\} \tag{2.15}$$

After rearranging (2.14) and (2.15), pure forward-looking NKPC is

$$\pi_{H,t} = \beta E_t\{\pi_{t+1}\} + \lambda mc_t \tag{2.16}$$

where $\pi_{H,t} = p_t - p_{t-1}$ and refers to the inflation rate and mc_t is the difference between the actual and steady-state values of the marginal cost. Also, $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}$ depends on the probability of keeping prices constant, θ, and discount factor, β. In equation (2.16), an increase in θ means that the number of firms that do not change prices increases. Therefore, a rise in θ decreases the λ and consequently reduces the π_t. Also, β is a measure of the effect of forward-looking inflation expectation on current inflation. Furthermore, the inflation rate is also affected by all possible future values of the marginal cost:

$$\pi_{H,t} = \lambda\sum_{k=0}^{\infty}\beta^k E_t\{mc_{t+k}\} \tag{2.17}$$

On the other hand, although the pure forward-looking NKPC is precious in terms of its theoretical basis, research about this form revealed some empirical failures. For instance, equation (2.17) states that the monetary authority can control inflation if it can manage expectations about future output gaps. This idea refers to the phenomena of costless disinflation, which means inflation can be reduced without output loss. However, Fuhrer and Moore (1995) emphasize that this is an unrealistic outcome. According to them, the absence of inflation persistence in the model lowers the output cost of disinflation. Fuhrer and Moore (1995) show that lagged values of inflation are also very crucial for inflation persistence. Besides, Roberts (1997) moots two possible reasons for why reducing inflation is costly: inflation may be sticky rather than prices or expectations may be imperfect. The survey analysis of Robert (1997) demonstrates that the second one is the reason. He emphasizes that if expectations are not rational, this condition may affect the dominance of forward-looking expectations, and previous experience of economic agents can gain importance. Due to this imperfection, reducing the inflation rate associates with an output cost. In summary, all these analyses demonstrate the importance of a backward-looking component on the PC.

Considering the significance of backward-looking expectations, Gali and Gertler (1999) develop a hybrid NKPC. In this model, they assume that $(1-\omega)$ of the firms have forward-looking expectations, while the remaining (ω) have backward-looking expectations on their price-setting decision. Thus, the aggregate price level in the Calvo style is

$$p_t = \theta p_{(t-1)} + (1-\theta)\overline{p}_t^* \tag{2.18}$$

where $\overline{p}_t^*$ is the general price index, which depends on the prices of forward-looking $(p_t^f)$and backward-looking (p_t^b) price setters in the market and it is

$$\overline{p}_t^* = (1-\omega)p_t^f + \omega p_t^b \tag{2.19}$$

Rearranging, (2.18) and (2.19) yields the following equation for future prices:

$$p_t^f = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\{mc_{t+k}^n\} \tag{2.20}$$

Also, backward-looking price setting depends on the following equation is

$$p_t^b = p_{t-1}^* + \pi_{H,t-1} \tag{2.21}$$

After rearranging (2.18), (2.19), (2.20), and (2.21), hybrid NKPC is

$$\pi_{H,t} = \lambda mc_t + \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} \tag{2.22}$$

where

- $\lambda \equiv (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}$
- $\gamma_f \equiv \beta\theta\phi^{-1}$
- $\gamma_b \equiv \omega\phi^{-1}$

- $\phi \equiv \theta + \omega[1 - \theta(1 - \beta)]$

In equation (2.22), real marginal cost and expectations of backward-looking and forward-looking expectation determines the current inflation. Besides, all the coefficients (θ, ω, β) are explicitly determined. θ indicates the share of firms that keep prices constant. It is the degree of price stickiness. An increase in price stickiness, θ, decreases the inflation rate. ω is the share of firms that set prices in a backward-looking manner. In the case of which $\omega = 0$ hybrid NKPC converges the pure-forward looking NKPC. Finally, a rise in β increase the inflation rate through y_f and y_b. (Gali and Gertler, 1999, 2-14).

Also, a critical discussion about the NKPC is the choice of the proxy for the real marginal cost. Several studies, including Gali and Gertler (1999), indicates that the output gap is not a good measure for the marginal cost. The failure of the output gap in empirical tests is generally accompanied by the difficulty of determining the measure of potential output. The GMM approach of Gali and Gertler (1999), based on US data, show that the labor share of income as the proxy for the marginal cost is a better determinant than the output gap to explain inflation. Besides, empirical results of Gali and Gertler (1999) emphasize that forward-looking expectations significantly dominate the effects of backward-looking expectations on inflation. Even though the backward-looking component is also significant, it is quantitatively very low in their model. Besides, Sbordone (2002) also indicates that forward-looking expectations are quite determinant in pricing dynamics. She also demonstrates that the labor share overcomes the output gap as a proxy of economic activity. In addition to these, Gali et al. (2001) examine the inflation dynamics in the Euro area. When they apply the NKPC framework, they reach satisfactory results. According to their results, the impact of the forward-looking expectation is greater than the US data.

In contrast, several papers assert that the NKPC models are the product of misspecification. The focus of these papers is the forward-looking structure of the model and the use of labor share of income as the proxy of marginal cost. For instance, Rudd and Whelan (2005a, 2005b, 2006, and 2007) criticize NKPC in many aspects. First, they emphasize that the supply shocks are omitted in the model, and they are used to determine forward-looking expectations. They argue that this modeling makes forward-looking expectations more important than it normally is. According to them, this not only makes the forward-looking component upward biased but also makes the backward-looking component downward biased. Second, Rudd and Whelan (2007) propound that, based on (2.17), if the NKPC framework is accurate and the labor share is the correct proxy for real marginal cost, then inflation also should be related to the expected future values of the labor share. Their analysis that focuses on this relationship gives a model with R^2 of 0.71, which is considerably good. However, almost all this good fit comes from the lagged values of inflation. Thus, they also conclude that the labor share fails to explain inflation dynamics. Similarly, Linde (2005) evaluates the estimation techniques of Gali and Gertler and specifies that their results are biased. He employs the Full Information Maximum Likelihood (FIML) method to estimate NKPC. The results of this paper also demonstrate that the pure forward-looking NKPC fails in the US, and the backward-looking component is more dominant in the model. On the other hand, Gali et al. (2005) reply to these critiques about NKPC. They defend the robustness of their NKPC models and advocate the dominance of the forward-looking term and success of the labor share as the appropriate proxy for real marginal cost.

In addition to these discussions, Mankiw and Reis (2002) take a different approach to PC analysis. Instead of sticky prices, they developed a model of sticky-information. In this model, a λ share of firms receives information about price level and the remaining set prices based on old information. In this case, the price level is

$$p_t = \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-j}(p_t + \alpha y_t) b \tag{2.23}$$

where j shows when firms adjust their plans. This price level can also be translated into the inflation form as[8]

$$\pi_t = \left(\frac{\alpha\lambda}{1-\lambda}\right) y_t + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(\pi_t + \alpha \Delta y_t) \tag{2.24}$$

In equation (2.24), inflation depends on current output, inflation expectations, and expectations about output growth, Δy_t. The most significant difference between the NKPC and (2.24) is the timing of expectations. While expectations about future values of driving variable determine inflation in equation (2.16), equation (2.24) indicate that

[8] See Appendix of Mankiw and Reis (2002) for detailed derivation.

inflation depends on past expectations about current inflation and output growth. Also, while price adjustment is costly in the sticky-price model, receiving information and reorganizing new plans are costly in sticky information PC.

In addition to these, one of the critiques about labor share is its countercyclical characteristic because marginal cost is generally procyclical. Mazumder (2010) tests the NKPC based on this point. He creates a labor share measure that considers the manufacturing sector, which is procyclical. However, both disaggregated and hybrid NKPC produces marginal cost with a negative coefficient, inconsistent with the theory. Moreover, Gordon (2013) specifies that the NKPC fails to explain the role of supply shocks in the 1990s, which the triangle model highlights. He shows that the performance of his triangle model is still very useful to explain inflation dynamics.

Another criticism about the NKPC is its forward-looking term (Rudd and Whelan, 2007). Starting from this point of view, some papers employ survey-based future inflation expectations. For example, Roberts (1995), Defour et al. (2006), and Nunes (2010) have supportive results for NKPC when they use surveys as the proxy of forward-looking inflation expectations. However, using these surveys to determine forward-looking expectations is unfavorable since participants may be unreliable or irrelevant (Abbas et al., 2016).

Overall, this section presents some facts about NKPC. Firstly, neither backward-looking nor forward-looking behaviors do not prove superiority on inflation dynamics. Besides, proxies used for forward-looking expectations and economic activity are still questionable. As yet, different PC frameworks that are presented are generally shaped based on the US economy, which is a closed one. The following subsection includes some extensions, such as opening the economy to catch the effects of international trade.

2.4.2. Open-economy New Keynesian Phillips Curve

Developments in international trade, transportation facilities, and technology have increased economic interaction across countries. Naturally, the interaction also increases the sensitivity of individual economies to developments in the world economy. As a result, some economic indicators such as exchange rate and terms of trade has become more critical for domestic economies.

Following the Gali and Gertler (1999), Gali and Monacelli (2005) present an open-economy NKPC (GMNKPC) model for a small open economy in the Dynamic Stochastic General Equilibrium (DSGE) framework by considering variables such as exchange rate and terms of trade. Introducing international trade (export and import) to the economy creates a gap between domestic consumption and output since consumer demand is met by domestic and foreign production in the open economy. The following equations show the optimal level of consumption in the small open economy:

$$C_{i,t} = \left(\frac{P_{i,t}}{P_{F,t}}\right)^{-\gamma} C_{F,t}\,; \qquad C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t; \qquad C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t \qquad (2.25)$$

where

- $C_{i,t}$ is the quantity of goods which are imported from country i and consumed in the domestic economy,
- $P_{i,t}$ is a price index (in domestic price) for goods imported from country i,
- $P_{F,t}$ is the price index for imported goods,
- $C_{H,t}$ is the consumption of domestic goods,
- $P_{H,t}$ is the domestic price index,
- P_t is the CPI, which is determined by domestic and foreign prices,
- C_t is the composite consumption index,
- $C_{F,t}$ is an index of imported goods.

Equation (2.25) is essential to understand the complex interrelationship in consumption preferences in an open economy. In general, domestic consumption demand in a small economy is a function of domestic and foreign prices. Therefore, the foreign exchange rate is a crucial determinant of the inflation rate through consumer demand.

The mathematical form of the GMNKPC is similar to the equation (2.16) that considers the closed economy:

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda\widehat{mc}_t \qquad (2.26)$$

In equation (2.26), $\pi_{H,t}$ refers to domestic inflation, and it depends on the forward-looking inflation expectations and the marginal cost. However, GMNKPC considers the CPI inflation, π_t, that is also affected by foreign shocks:

$$\pi_t = \pi_{H,t} + \alpha\Delta s_t \qquad (2.27)$$

where Δs_t represents the change in terms of trade. In equation (2.27), the openness degree of the economy, α, determines the measure of the effect of terms of trade on inflation. Moreover, rearranging equation (2.26) and (2.27) yields the following equation:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda \widehat{mc}_t + \alpha(\Delta s_t - \beta E_t \Delta s_{t+1}) \qquad (2.28)$$

In equation (2.28), inflation is also a function of the difference between the realized and expected future change on the terms of trade, differently from the pure forward-looking NKPC. Under the assumption of complete exchange rate pass-through ($q_t = (1-\alpha)s_t$), equation (2.28) can also be rewritten as a function of the exchange rate:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda \widehat{mc}_t + \frac{\alpha}{1-\alpha}(\Delta q_t - \beta E_t \Delta q_{t+1}) \qquad (2.29)$$

Equation (2.29) demonstrates the effects of the exchange rate on CPI inflation. Also, where the relationship between the marginal cost and output gap for a small open economy is given by $\widehat{mc}_t = (\sigma_\alpha + \varphi)x_t$, equation (2.29) translates into:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_\alpha \hat{x}_t + \frac{\alpha}{1-\alpha}(\Delta q_t - \beta E_t \Delta q_{t+1}) \qquad (2.30)$$

where

- $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}$
- $\kappa_\alpha \equiv \lambda(\sigma_\alpha + \varphi)$
- $\sigma_\alpha \equiv \frac{\sigma}{(1-\alpha)+\alpha\omega}$
- $\omega \equiv \sigma\gamma + (1-\alpha)(\sigma\eta - 1)$.

In equation (2.30), θ shows the degree of price stickiness, σ indicates the inter-temporal elasticity of substitution in consumption, φ is the measure of the inter-temporal trade-off between labor and leisure[9], γ represents the rate of substitution among goods which are produced in other countries, and η is the rate of the substitution of consumption preferences between domestic and imported goods.

In this respect, the openness degree of the economy, α, defines the slope of the GMNKPC. When $\alpha = 0$, equation (2.29) transforms into the closed economy model of

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[9] In Gali and Monacelli (2005), $C_t^\sigma N_t^\varphi = \frac{W_t}{P_t}$ is the optimality condition where C_t is the composite consumption, N_t is the labor, W_t is the nominal wage, and P_t is the CPI.

equation (2.16). Also, the foreign shocks in equation (2.30) come from the difference between the current and expected future values of the terms of trade and exchange rate. Besides, GMNKPC assumes that all imported goods are final consumption goods, and they are not used in the production process. Considering this, change in the exchange rate directly affects the inflation under the complete exchange rate pass-through effect.

On the other hand, this specification of the NKPC is also criticized in some respects and fails in many empirical tests. For example, Allsop et al. (2006) analyze the inflation dynamics in the UK, and they found an insignificant relationship between the exchange rate and inflation when imported goods are assumed as final consumption goods as Gali and Monacelli (2005) do. However, when they leave this assumption and consider the effects of imported intermediate goods, the relation turned into the significant one. Also, Mihaliov et al. (2011) estimates the GMM model of GMNKPC and focuses on the impact of terms of trade on inflation in OECD countries for a period that covers 1970-2011. Their results suggest that changes in terms of trade are a more important driver than the domestic output to explain inflation in most countries. Consequently, Mihailov et al. (2011) partly support the framework of GMNKPC.

Besides, Abbas et al. (2015) investigate the inflation dynamics in Australia under the GMNKPC framework. Their analysis for the Australian case, which covers the 1959-2010 period, does not give supportive results. Moreover, Abbas et al. (2016) present a valuable survey about the recent developments in NKPC and tests the GMNKPC for four different countries.[10] The results of this paper also reveal its failure. Abbas et al. (2016) attribute this weakness to the strong assumptions of GMNKPC like all imported goods are final consumption goods, which are not used in the production process. When Abbas et al. (2016) leave this unrealistic assumption and consider imported intermediate goods costs, their model explains inflation dynamics better than the former.

On the other hand, Balakrishnan and Lopez-Solido (2002) present another model for the inflation dynamics in the open-economy. The following model considers the effects of the prices of imported goods on firms' marginal costs:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda\big((1-\alpha)\widehat{mc}_t + \alpha(p_t^m - p_t)\big) \qquad (2.31)$$

[10] These countries are Australia, Canada, New Zealand, and the United Kingdom.

Differently from the previous specifications of the GMNKPC, the relationship between the marginal cost and inflation is determined by $\lambda(1-\alpha)$ in equation (2.31). More clearly, the openness degree of the economy affects the inflation rate via firms' marginal costs in addition to relative prices of imported goods, p_t^m. When $\alpha = 0$, the effect of the openness and import prices disappear, and equation (2.31) converts to the pure forward-looking NKPC after this restriction is applied.

Furthermore, Batini et al. (2005) also extend the NKPC, which includes both price and employment adjustment costs in the UK. Also, they consider the imported intermediate input costs in the model. Their results indicate that the labor share is an accurate proxy for the marginal cost when employment adjustment costs are involved. Also, their results reveal that import prices are an essential determinant of inflation and forward-looking inflation expectations are dominant in the UK for the period of investigation. Besides, Rumler (2007) estimates an open economy hybrid NKPC for euro area countries. The results highlight the significant effects of imported intermediate goods on inflation dynamics. Also, Rumler (2007) concludes that forward-looking expectations are dominant in almost all countries. Besides, the study reveals the heterogeneity in pricing dynamics across countries.

Leith and Malley (2007a) present another extension for the NKPC framework. They also extended the model to capture the terms of trade effect on pricing dynamics via marginal cost. Their data covers the 1960-1999 period for G7 countries. The GMM results give remarkable results about the price-setting decisions of firms in the countries. Accordingly, while the behavior of the firms with less frequent price changes is forward-looking, firms with a high frequency of price changes behave in a backward-looking manner.

In addition to these, Watson (2016) analyzes the effects of competition and trade openness on trade dynamics by employing the New Keynesian DSGE framework. Watson (2016) put forward two opposite effects of openness. On the one hand, the variety of goods in the market rises following an increase in the openness of an economy. It makes price adjustment costlier because openness provokes the competition, and the rise in competition increases the price elasticity of demand. Thus, this also causes a rise in the real price rigidity, and this case produces a flatter PC. On the other hand, the openness of an economy elevates the opportunity cost of firms to deviate their prices from the profitmaximizing price in the market. That is, firms change their prices more frequently. It decreases the nominal rigidities. In other words, the responsiveness of inflation increases, and the PC becomes steeper. Consequently, Watson (2016) demonstrates that the second effect dominates the first one for highly integrated countries. Also, this study reveals that domestic inflation is not only determined by domestic real marginal cost but also determined by relative prices of domestic goods respect to prices of imported goods.

In summary, international economic dynamics have huge effects on the domestic inflation rate. Primarily, changes in the exchange rate and terms of trade influence the prices in small open economies. Also, the effects of imported intermediate goods that are used in the production process are more remarkable. By contrast, assuming that all imported goods are final consumer goods is not realistic. Consequently, this subsection points out that inflation dynamics cannot be analyzed as if the domestic economy is irrelevant from the rest of the world.

3. EMPIRICAL ANALYSIS

3.1. The Model

This study aims to reveal the determinants of the inflation rate in the Turkish economy. In line with this purpose, this subsection introduces the model that the study employs. The descriptive analyses in Section I indicates that prices in Turkey are very flexible, and the main driver of frequent price changes are cost shocks. Where these cost shocks generally come from the movements in the exchange rates, these fluctuations also deteriorate the expectations of firms and raise the behavior of backward-looking indexation at prices. Besides, even though the effects of cost shocks are more dominant in pricing behaviors, demand developments are also crucial in price-setting decisions. In the light of these, the appropriate framework to explain Turkish inflation dynamics is the modern PC in equation (2.13) that considers the effects of backward-looking inflation expectations, the output gap, and cost shocks.

On the other hand, the descriptive analyses in Section I and the theoretical background in Section II point out some crucial facts. First, the movements in economic indicators generally affect the prices with time lags. Second, the relationship between economic activity and the inflation rates vary across time horizons. Based on these, we prefer to use the Autoregressive Distributed Lag (ARDL) model to estimate the PC's. In short, the ARDL model is a method that includes both lagged values of dependent and independent variables as explanatory variables (Cartel Hill et al., 2011). The modern PC in ARDL form can be represented as:

$$\pi_t = \beta_0 + \beta_1 \sum_{i=1}^{k} \pi_{t-i} + \beta_2 \sum_{i=0}^{m} x_{t-i} + \beta_3 \sum_{i=0}^{n} p_{t-i} + \mu_t \tag{3.1}$$

where $x = (y - y^*)$. This model is represented as ARDL (m, n, k) since it includes k lags of π, m lags of x, and n lags of p. In the estimation process, optimum values of $k, m,$ and n are selected based on different selection criteria such as Akaike Information Criteria (AIC) and Schwarz Criteria (SC).

Moreover, the ARDL method is very applicable in time series analyses in many aspects. Firstly, it analyzes the relationships among variables at different levels. More clearly, the model can be estimated with series that are stationary in level, I(0), or first differences, I(1). However, variables that are stationary at I(2) (or more) cannot be used in the ARDL estimation. Also, this method presents valuable insights into the long-run dynamics based on the ARDL Bounds Test model (Pesaran and Shin 1998; Pesaran et al. 2001). An ARDL Bounds Test model of the equation (3.1) can be represented as:

$$\Delta\pi_t = \beta_0 + \underbrace{\beta_1\sum_{i=1}^{k}\Delta\pi_{t-i} + \beta_2\sum_{i=0}^{m}\Delta x_{t-i} + \beta_3\sum_{i=0}^{n}\Delta p_{t-i}}_{Short-run\ dynamics} + \underbrace{\varphi_1\pi_{t-1} + \varphi_2 x_{t-1} + \varphi_3 p_{t-1}}_{Long-run\ dynamics} + \varepsilon_t \quad (3.2)$$

In equation (3.2), where β's are short-run coefficients, φ's refers to long-run coefficients. After estimating the model, the following F-bound test is applied to see if there is a statistically valid cointegration in the model.

$\varphi_1 = \varphi_2 = \varphi_3 = 0$ (There is no cointegration)

$\varphi_1 \neq \varphi_2 \neq \varphi_3 \neq 0$ (There is a cointegration)

When F statistic is higher than the upper bound, the null hypothesis, H_0, is rejected. It means that there is cointegration in the model. Furthermore, the following Error Correction Model (ECM) gives some clues about the characteristics of the long-run relationship.

$$\Delta\pi_t = \beta_0 + \beta_1\sum_{i=1}^{k}\Delta\pi_{t-i} + \beta_2\sum_{i=0}^{m}\Delta x_{t-i} + \beta_3\sum_{i=0}^{n}\Delta p_{t-i} + \varphi ECT_{t-1} + \varepsilon_t \quad (3.3)$$

where ECT is the error correction term. In equation (3.3), φECT_{t-1} is replaced with the long-run coefficients of equation (3.2). In ECM, the coefficient of the error correction term, φ, shows the speed of adjustment to the long-run equilibrium. In other words, it indicates the speed of the correction from the deviation of the long-run equilibrium. Because the deviation is corrected in time, φ should be negative and individually significant for a statistically significant long-run relationship. Furthermore, since ECT_{t-1} is the residuals of the OLS model ($\pi_t = \beta_0 + \beta_1 x_t + \beta_2 p_t + ECT_t$), the long-run model for this framework can be represented as:

$$ECT_{t-1} = \pi_{t-1} - (\beta_0 + \beta_1 x_{t-1} + \beta_2 p_{t-1}) \quad (3.4)$$

In this study, we firstly estimate equation (3.1) for the general CPI and the selected subcomponents of it based on the proper lag-length criterion. Equation (3.2) and (3.3) respectively tests the existence of cointegration in the models and aims to see the speed of adjustment to the long-run equilibrium. Finally, equation (3.4) gives the long-run inflation dynamics in the models

3.2. Literature Review

3.2.1. Studies on Inflation Dynamics in Turkey

This subsection aims to investigate the PC studies in Turkey and take a picture of Turkish inflation dynamics based on the recent literature. In the recent literature of the PC on Turkey, many studies directly used some theoretical basis in the previous section. Some others created different models to explain the determinants of inflation. Also, a couple of studies analyzed specific prices, such as food prices and oil prices.

Some early papers test the validity of the PC for Turkey. For example, Yazgan and Yılmazkuday (2005) found some support for pure forward-looking NKPC in Turkey by employing quarterly data between 1988:Q2-2003:Q1. They also compare their study with Gali and Gertler (1999), and they found that prices are more flexible in Turkey. Besides, Kuştepeli (2007) uses annual and semiannual data, respectively, for 1980-2001 and 1988:2-2003:1 period. The results of this study show that the PC does not exist for Turkey. Moreover, Gözgör (2013) estimates both baseline PC and the NKPC for Turkey. He uses monthly data between 2005:01-2012-06 period. Consistent with Yazgan and Yılmazkuday (2005) and Kuştepeli (2007), while the NKPC framework is valid for Turkey in this study, the baseline PC is not valid for Turkish data. Furthermore, Hepsağ (2009) analyze the inflation-unemployment relationship based on the ARDL approach. The study considers quarterly data that covers 2000:Q1-2007:Q3 period. Results indicate that the most significant determinant of inflation is its own lagged values in the corresponding period.

Besides, most of the literature in Turkey focuses on the relationship between inflation, unemployment, and economic growth. Gül et al. (2014) examine the causality between inflation and unemployment using the data covering 1996-2012. As a result, they found a long-term relationship from inflation to unemployment. Also, Başer Andiç et al. (2015) estimate an NKPC model for the Turkish economy for 2003Q2-2012Q3 period. Their results indicate that backward-looking and forward-looking expectations are equally crucial in this period. However, their analysis also indicates that the prominence of backward-looking expectations decreased after 2003, due to the credibility gaining of the CBRT. In addition to these, Ayvaz Güven and Ayvaz (2015) analyze the inflation-unemployment relationship for the 1990-2014 period. They use the Vector Autoregressive (VAR) method and found causality from unemployment to inflation. On the other hand, Tabar and Çetin (2016) also test the validity of the PC for the Turkish economy. They used monthly data for the 2003-2006 period, and they conclude that the PC theory is not valid for the Turkish economy.

Özçelik and Uslu (2017) employ monthly data between 2007 and 2014. Results of VAR analysis reveals the existence of the strong bidirectional relationship between unemployment and economic growth. However, their findings indicate that there is no causality between inflation and unemployment or economic growth. Besides, Petek and Aysu (2017) employ monthly data to examine the inflation-unemployment relationship for the 1980-2015 period. In their VAR model, they found a long-run relationship between variables, but they do not find any causality between them. Also, Topcu (2017) investigates the causal relationship between the inflation rate and economic growth by using quarterly data between 2006:Q1-2017:Q2. The results of the paper indicate that there is a long-run causality from economic growth to inflation rate. Also, the results of Alper (2017) reveal the existence of the long-run relationship between inflation and unemployment for the 1987-2016 period. Similarly, Bildirici and Sonüstün (2018) used the non-linear ARDL method for the period of 1960-2016. Their empirical tests show that there is a long-run relationship between inflation and unemployment in the Turkish economy.

Işık Maden et al. (2018) also investigate the relationship between inflation and unemployment for the 1980-2016 period. While they detect a long-run relationship between variables resulting from cointegration analysis, their Vector Error Correction (VEC) model indicates that a change in inflation negatively affects unemployment with one-period lag. Furthermore, Dereli (2019) examines the inflation-unemployment relationship for the 1988-2017 period applying the ARDL method. This study also reveals that there is a long-run relationship between variables. Besides, Şahin (2019) analyzes the inflation-unemployment relationship for 2005:01-2017:04 period in monthly data. Her findings indicate that there is a long-run causality from unemployment to inflation.

On the other hand, the literature includes several studies about the behaviors of some individual prices. For instance, Özmen and Sevinç (2016) analyze pricing dynamics in Turkey for the 2006-2011 period. Results show that prices are flexible in Turkey, and there is heterogeneous behavior between and within the different categories of goods and services. Besides, Lopcu and Şengül (2018) investigate the impact of food prices on inflation volatility in Turkey. They use monthly data for 1995:01-2017:10. Their findings show that food inflation and the exchange rate of the dollar have a significant effect on inflation volatility. Also, Eren et al. (2017) analyze the dynamics of food prices based on 35 selected items in 1994-2016. They found that while export has an increasing effect on food prices, import negatively affects them. Besides, Koca and Yılmaz (2018) investigate differences in inflation dynamics between services and core goods. They utilize quarterly data for the 2007Q1-2018Q2 period. According to their results, while the exchange rate significantly affects core goods inflation, inflation in services is driven by real unit wage, food prices, and headline inflation. Also, the findings reveal that volatility in the services sector is more considerable than the one in the core goods sector.

Also, some studies concentrate on the interaction between inflation and several economic indicators. For example, Ergin (2015) investigates the relationship between the exchange rate and inflation. He conducts VAR methods for the period of 2005:02-2014:12. The findings indicate a transmission mechanism passing through the exchange rate, intermediate goods, and inflation. Besides, Öğünç et al. (2018) investigate inflation dynamics in Turkey by using the Bayesian VAR model with quarterly data for the period of 2005Q2-2016Q2. Consistent with Ergin (2015), they found that the impact of the exchange rate on inflation is powerful and more substantial than the effects of import prices. Besides, the study reveals the significant impact of wage shocks on inflation. However, wage shocks affect the economy after a longer time than the other factors such as exchange rate and import prices.

Furthermore, Atabay (2016) examines the relationship between the inflation rate and openness by applying the OLS method. Their results indicate an inverse relationship between trade openness and inflation for the 1980-2011 period. Moreover, Akçelik and Öğünç (2016) analyze the effects of oil prices on domestic goods and services prices in Turkey. They use monthly data for 2004:01-2014:09 period. Their PC model demonstrates that the effect of a change in oil prices on producer prices is two times higher than its effects on consumer prices.

Gökmenoğlu et al. (2015) employ data from 1961 to 2012 and analyze the relationship between industrial production, GDP, inflation, and oil prices. Results show that changes in oil prices have significant effects on industrial production. Besides, Yıldırım (2015) analyzes the relationships among productivity of labor, real wages, and the inflation rate in Turkey for 1988:Q1-2012:Q2 period by using quarterly data. The results o this study highlights a remarkable long-run relationship between inflation and productivity. In addition to these, Doğan et al. (2016) investigate the relationship between inflation and interest rates in the Turkish Economy for the 2003:01-2015:02 period in monthly data. The result of Granger causality tests indicates that there is causality from the inflation rate to interest rates.

Some studies investigate unemployment hysteresis. Kılıç et al. (2018) investigate this theory for the 1980-2017 period, and they found a hysteresis effect on unemployment in Turkey. Additionally, Can et al. (2019) cover a period from 1923 to 2018 for the same object. Their results reveal that the unemployment rate in Turkey is not stationary. It means that the theory is valid for Turkey.

Duran (2017) and Yeşilyurt and Elhorst (2014) analyze the inflation dynamics at regional levels. The findings of the Duran (2017), for the 2004-2015 period, reveal that the level of differences across regions declines over time. Besides, Yeşilyurt and Elhorst (2014) estimate regional-based hybrid NKPC based on 67 provinces in Turkey over the 1987-2001 period. They found that backward-looking behavior is dominant in Turkey, and there are discrepancies in inflation rates across regions.

Apart from these, some studies deal with how the output gap is measured. Şahinöz and Atabek (2016) propose a capacity utilization gap, and they used firm-level data. They indicate that these kinds of measures are useful because they can be derived before GDP data are obtained. Therefore, they emphasize that such an output gap is also more useful for policy purposes. In another study that uses micro-based information to have an output gap measure, Çelgin and Yılmaz (2019) evaluate the different sub-categories of consumption basket and create a new sectoral output gap indicator by using Hodrick-Prescott (HP) filter, considering the monthly data that covers the 2005-2018 period. They also test the sectoral output gap in PC estimation, and the result of this estimation reveals the robustness of it.

In addition to these, some thesis concentrates on inflation dynamics in Turkey. For example, Korkmaz (2009) employs quarterly data for the 1997Q4-2006Q4 period to estimate the NKPC. The results of the analyses put forward the importance of expectations (both backward-looking and forward-looking) on the determination of current inflation. Also, Eruygur (2011) analyzes the inflation dynamics in Turkey under the NKPC framework. This model includes the effects of imported intermediate goods and exchange rate dynamics. In estimations, the inclusion of open economy factors strengthens the validity of the model. Moreover, the study reveals that NKPC can explain inflation dynamics in Turkey for the 1988Q1-2009Q4 period. Also, the results indicate that inflation is determined in a backward-looking manner for the period under investigation, although the IT regime succeeds in decreasing inflation inertia in Turkey. Besides, Kızıl (2019) estimates a hybrid NKPC by employing quarterly data for the 2001Q3-2016Q2 period. In this study, the implication of the Non-Linear ARDL model and the inclusion of open-economy variables strengthen the explanatory power of the model. Also, the study emphasizes that the implementation of the IT regime increases the credibility of the CBRT and affects the expectations positively. Furthermore, Dikbaş (2019) investigate the inflation dynamics in Turkey by using pure forward-looking and hybrid NKPC models. The quarterly data covers the 2005Q4-2018Q2 period. The period begins with the starting of the implicit IT regime. GMM results of both models show that the output gap cannot explain current inflation, and forward-looking expectations significantly dominate the backward-looking expectation.

On the other hand, Özaksoy (2015) analyzes the relationship between inflation and unemployment in some countries, including Turkey. For the period that covers 1955-2014, the results show no linear and long-run relationships between the variables. However, the non-linear ARDL model reveals the existence of the long-run negative relationship between inflation and unemployment. Also, Erol (2017) focuses on food inflation. The paper uses monthly data that covers the 2003:01-2013:12 period. The results of the analyses reveal that supply-side factors have a significant influence on food prices. Besides, movements in the exchange rate also significantly affect food prices through imported input prices in Turkey. In addition to this, Tekgün (2017) conducts an interregional study to generate a PC for Turkey. The starting point of the study is to reveal the impact of heterogeneity in pricing dynamics across regions. The study considers 26 regions and uses the Panel ARDL model for the 2005-2011 period. The results show that the PC is valid for 17 of the 26 regions in the short run. It means that there is a negative relationship between inflation and unemployment. However, the result which indicates the long-run positive relationship between variables contradicts the theory. More importantly, the study reveals that determinants of inflation significantly differ across regions.

Consequently, inflation dynamics in the Turkish economy has been examined in many aspects. Most studies focus on the relationship between the inflation rate and unemployment or economic activity. However, there is no consensus about the characteristic of this relationship. Besides, several papers indicate that shocks that come from the exchange rate and import prices are very crucial in determining the inflation rate. Moreover, micro-level analyses demonstrate that inflation dynamics are heterogeneous across sectors and regions.

3.2.2. Studies on Disaggregated Phillips Curve

Studies on disaggregated PC does not extend back a long time, but the number of them has increased with the rise in the availability of micro-level data. This subsection presents recent literature about these types of studies. Many of them are also the source of inspiration for the present work. This approach generally decomposes the CPI into its subcomponents or disaggregating the sectors. Then, the inflation dynamics of these components are separately analyzed. This type of analysis gives valuable insight into several subjects such as heterogeneity of pricing dynamics across sectors and discrepancy in responses to monetary policy actions. To sum up, this subsection aims to understand the general approach that aggregates PC.

In general, pricing dynamics in different sectors vary due to various reasons. On the demand side, the response of individual demand to monetary policy differs across sectors. For instance, while an increase in interest rate sharply cut the demand in a sector in which the demand preferences of consumers are elastic, this increase may not have a significant effect in another sector in which the consumer demand is inelastic. Besides, the impact of shocks and adjustment cots of prices that firms face are different. This inconsistency reflects the prices, too (Erceg & Levin, 2006; Abbas et al. 2016; Apaita et al. 2020). Naturally, heterogeneous characteristics across sectors are crucial for an aggregate inflation analysis. Catching such differences in inflation dynamics at the aggregate data is challenging.

As an early example of disaggregated studies on inflation dynamics, Leith and Malley (2007b) estimate sectoral hybrid NKPC for the US manufacturing industries for the 1959-1996 period. Referring to failures about the labor share, they take intermediate goods costs as the measure of marginal cost. In general, results of sectoral analyses support the NKPC with the dominancy of forward-looking price setting. However, sector-specific analyses also imply the discrepancy in the degree of price stickiness across sectors: prices in the durable-goods industry are relatively higher than the non-durable-goods industries.

Imbs et al. (2011) analyze heterogeneous pricing behaviors in France in a sample that has 16 sectors. They emphasize that if there is heterogeneity in pricing behavior across firms, an aggregated PC cannot explain the general inflation dynamics. Their results also reveal that the aggregated PC is biased when the pricing behavior of firms differs. While this study uses French data, Lawless and Whelan (2011) examine Europe and the US. They employ the data from 630 sectors in 15 countries for Europe and 459 manufacturing sectors in the US. The results of this study do not support the NKPC for most sectors due to the heterogeneity of pricing behavior. However, their sectoral level data produces better results than the aggregate level data does. Also, they found a significant variation on mark-up over marginal cost across different sectors.

In addition to these, Ibrahim and Said (2011) examine oil prices pass-through effects on disaggregated consumer prices. They conduct an ECM and decompose the CPI into four sub-components.[11] The findings indicate that the effect of oil prices on food prices is relatively the strongest one for Malaysia.

Petrella and Santoro (2012) used sectoral data from 458 manufacturing industries in the US, which covers the 1958-1996 period. They found significant support for NKPC

[11] These are the food prices, rent, fuel and power prices, transportation and communication prices, and medical care and health price index (MHPI).

at the sectoral level, and they also emphasize that the labor share is an appropriate proxy for real marginal cost. This result is contrary to the previously mentioned study of Mazumder (2010) that rejected NKPC at the sectoral level.

Besides, Bunn and Ellis (2012) use weekly data for the 2005-2008 period in the UK, and they conduct a descriptive study through individual supermarket prices. The study shows that pattern of prices is different across sectors. Moreover, the data indicate that goods prices are more flexible than prices in the services sector.

Byrne et al. (2013) analyze the inflation dynamics in the sectoral level in 14 OECD countries[12] based on the NKPC approach. The study concludes that the influence of marginal cost on inflation is more substantial when the disaggregated approach is used instead of the aggregated one. Authors emphasize that this stems from the sectoral heterogeneity. On the other hand, empirical analyses of the paper find out a curious discrepancy across countries. According to this, the NKPC performs better in bigger countries in contrast with smaller countries. Authors moot that this may be due to the weakness of NKPC assumptions such as monopolistic competition and sticky prices in small countries. Also, Norkute (2015) investigates the consistency of sectoral NKPC in the Euro area.[13] They consider the 1999-2012 period, quarterly, and found only weak support for sectoral NKPC.

Abdih et al. (2016) analyzed inflation dynamics in the US in five different sub-components of Personel Consumption Expenditure (PCE) for 1996Q1-2015Q4.[14] They decompose them to their sub-components for in-depth analysis and use General Unrestricted Model (GUM). According to the results, domestic factors have relatively larger effects on the services sector, whereas foreign factors are relatively more effective in the goods sector. Additionally, Luengo-Prado et al. (2017) test the validity of the sectoral PC for a period that covers 1986Q1-2017Q3. They separate data into 16 categories, which represent %94 of CPI, and found that there is a significant change in disaggregated PC around 2009-2010 due to the GFC. Also, the result of this study reveals that inflation seems more forward-looking after the end of the recession.

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[12] These countries are Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, The Netherlands, Portugal, Spain, Sweden, UK, and U.S.

[13] The sectors used in the study: agriculture, manufacturing, construction, services and other business services

[14] These are imports, core goods, core services, housing services, healthcare services.

Moreover, Abbas et al. (2016), which is previously mentioned, also tests the NKPC in the sectoral level. Even though they reject NKPC of Gali and Gertler (1999) and Gali and Monacelli (2005) at the aggregated level, their disaggregated results indicate the ability of NKPC to explain inflation dynamics. In addition to these, Lanau et al. (2018) decompose the CPI into four sub-components.[15] They use quarterly data for the 2002-2017 period and estimate a triangular PC by applying the ARDL method for Colombia. They evaluate every disaggregated subcomponent of the CPI with related determinants that they can be dependent on. Consequently, they found that the effects of supply shocks on tradable goods and food prices are relatively larger. Their result also shows that applying a disaggregated approach increases the forecasting ability of the models.

Guo et al. (2019) decompose the Philippines' prices into four sub-components.[16] They estimate disaggregated PC's by using quarterly data between 2002Q1-2018Q4, and they find significant results by employing this approach. Besides, Apaitan et al. (2020) examine Thai inflation dynamics with disaggregated price data. They collect data for 8317 products across 77 provinces in Thailand and employ monthly data covering the 2002-2017 period. As in many other studies, this study also reveals the significant heterogeneity across CPI categories, sectors, and time. Besides, their results emphasize that the effects of the monetary policy vary across sectors when pricing behaviors are heterogeneous.

Saygılı (2020) estimates an open-economy NKPC for 17 OECD countries to examine sectoral inflation. They use the approach in Gali and Monacelli (2005). The study considers data at the sectoral level for the 1990-2016 period. The result of this study supports that both domestic and external factors are crucial in the inflation dynamics of selected countries. Besides, the findings reveal that coefficients of the models for different subsectors significantly differ.

Atuk et al. (2018) investigates the inflation dynamics in Turkey at the disaggregated level. They employ 152 sub-items of general CPI for the 2004-2016 period with quarterly data for analyzing the sensitivity of different goods and services to the output gap. Their results indicate that one-third of the consumer basket is dependent on the output gap. The

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[15] These are tradables, non-tradables, food, and regulated prices. Also, they decompose non-tradables and tradables into education, rent, and other for the former, and fuel, transportation, and public services for the latter.

[16] These are food and energy basket, non-market-based basket, core services basket, core goods basket.

other part of price changes is mostly driven by import prices, and the exchange rate pass-through effect.

In summary, a disaggregated approach to inflation dynamics provides a comprehensive analysis of heterogeneous pricing behaviors in different subcomponents of the CPI. Besides, the effects of some critical variables, such as inflation expectations and exchange rate, vary across sectors. Moreover, responses of demand to monetary policy also vary across sectors. In short, studies in this subsection reveals that ignoring the heterogeneity in price setting may produce biased and inefficient results for inflation dynamics.

3.3. Data and Estimation Method

This subsection presents the data and estimation method that we use in the models. This study estimates the seven ARDL models to analyze the inflation dynamics in the Turkish economy. One of these models refers to the general CPI, where the remaining six models focus on six subcomponents of the CPI. These models employ 22 quarterly data for a period that covers 2003Q1-20201. The source of the data, except one of them, is the Electronic Data Delivery System of the CBRT. Besides, the data for Europe Brent Oil Prices is drawn from the US Energy Information Administration.

The CPI that the TSI calculates has 12 subcomponents. However, this study draws 6 of them to use in the models. Table 3.1 indicates the weights and contents of these selected subcomponents. As represented in the table, these subgroups compose about %75 of the general CPI. The study ignores the subgroup of alcohol and tobacco prices since the tax regulations generally determine the significant portion of prices in this group. It also keeps out some subgroups such as education, communication, health, and recreation because the weights of these groups in CPI and their effects on inflation are relatively ignorable.

Table 3.1. *Subcomponents of Consumer Price Index (Source: TSI)*

Subcomponents[17]	Weights[18]	Contents
CPI_1: Food and Non-Alcoholic Beverages	**%22.77**	• Food • Non-alcoholic Beverages
CPI_3: Clothing and Footwear	**%6.96**	• Clothing • Footwear
CPI_4: Housing, Water, Electricity, Gas, and Other Fuels	**%14.34**	• Actual Rentals for Housing • Maintenance and Repair of the Dwelling • Water Supply and Miscellaneous Services Relating to the Dwelling • Electricity, Gas, and Other Fuels
CPI_5: Furnishings, Household Equipment, Routine Maintenance of the House	**%7.77**	• Furniture and Furnishings, Carpets and Other Floor Coverings • Household Textiles • Household Appliances • Glassware, Tableware, and Household Utensils • Tools and Equipment for House and Garden • Goods and Services for Routine Household Maintenance
CPI_7: Transport	**%15.62**	• Purchase of Vehicles • Operation of Personel Transport Equipment • Transport Services
CPI_{11}: Hotels, Cafes, and Restaurants	**%8.67**	• Catering Services • Accommodation Services

Table 3.2 indicates some descriptive statistics about the selected CPI components. The table demonstrates that the increasing rates of CPI_1 and CPI_4 are higher than the average increase in the CPI. That is a remarkable statistic because the total weights of these groups in the consumption basket are about %37. Considering the contents of these groups reveals how the impacts of food and energy prices on general inflation dynamics are powerful. Besides, where clothing prices shows the lowest level of increase in related subgroups, the increase in the index of hotel and restaurant is higher than the other groups. Also, Table 3.2 indicates a positive correlation between the increasing rates and standard

[17] The sub-numbers refer the numbers in the original index of the TSI.
[18] Weights considers the distribution in August 2020.

deviations of the variables. In other words, uncertainty in prices accompanies a higher level of increase.

Table 3.2. *Descriptive Statistics of Subcomponents of CPI*

	CPI_0	CPI_1	CPI_3	CPI_4	CPI_5	CPI_7	CPI_{11}
Mean	214.51	231.36	150.40	240.01	179.59	209.73	291.50
Minimum	96.37	96.93	94.06	97.58	96.48	97.14	94.92
Maximums	448.35	539.30	266.46	495.29	372.03	424.97	668.81
Rate of Increases in the Related Period	365.22	456.35	155.43	407.59	273.88	337.46	604.60
Standard Deviations	93.90	116.52	45.54	105.19	73.07	89.40	155.24

Columns in Figure 3.1 introduces the time-series graphs of these subcomponents. These are also the dependent variables of empirical models of this study. Moreover, the base year of CPI_0 is 2003. All the subgroups are indexed on CPI_0 in the base year. The figures indicate an increasing trend in each component. The lines have become steeper in the last years. Also, these series refer to data at the level to understand the price changes in each series better. However, the study utilizes the log values of all variables in the models. On the other hand, these series are crucial for the study because TSI calculates the inflation rate in Turkey, which is the target of the CBRT, as the percentage change in these variables. For that reason, these series introduce to models as dependent variables as an indicator of the inflation rate. Moreover, because the base model of the study includes sticky (backward-looking) inflation expectations, the lag values of these variables enter models as the proxy of inertia.

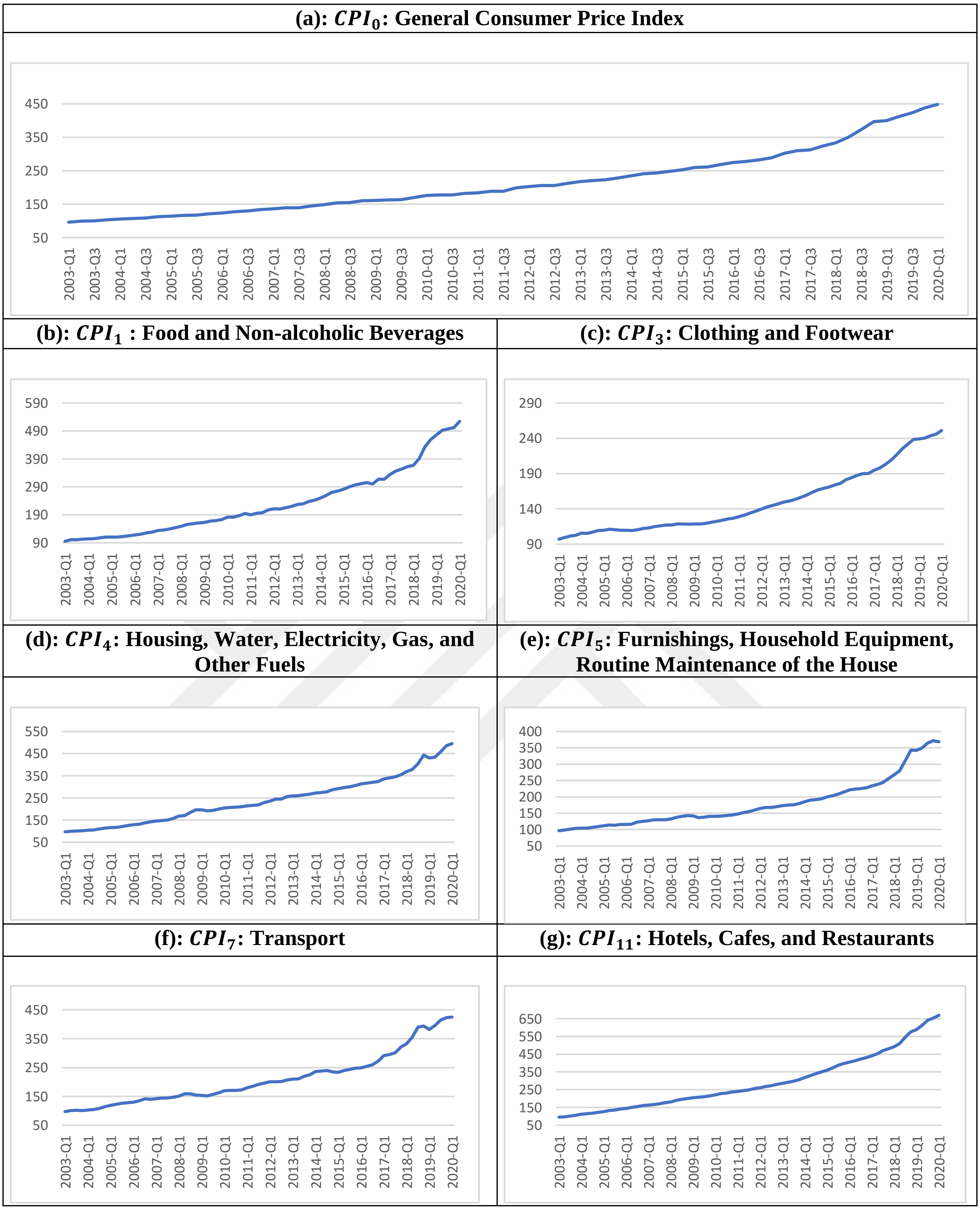


Figure 3.1. *Dependent Variables of the Models (EDDS, 2020)*

Figure 3.2 shows two output gap variables that the models utilize. First, the gap from the M2 money supply is used as a proxy of the output gap. Since the money supply refers to the amount of money in the market, it is a useful indicator of demand dynamics. Second, because the Industrial Production Index (IPI (2015=100)) indicates the production dynamics in the economy, it is accepted as a priori indicator for the GDP. Therefore, it is also employed as a proxy for the output gap.

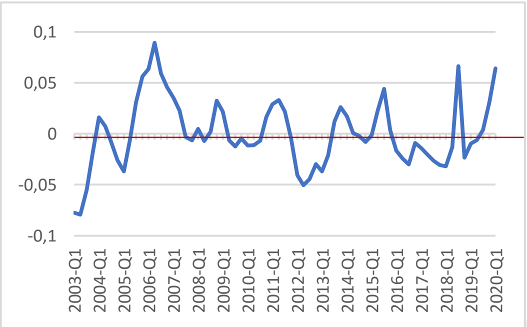
(a): GAP_m: Output Gap (M2 Money Supply)	**(b): GAP_y: Output Gap (IPI)**
	

Figure 3.2. *Output Gap Variables (EDDS, 2020)*

These output gaps, the differences between the actual and the trend series of these variables, are employed to reveal the demand pressure on prices. To derive them, we apply the Hodrick-Prescott Filter to the seasonally adjusted log values of the M2 Money Supply and the IPI. The blue lines in Figure 3.2 (a) and (b) indicates these output gaps. In both figures, while the upper sides of the red lines are the parts of the positive output gaps, the undersides present the negative output gaps. These positive and negative output gaps respectively symbolize the upward and downward demand pressures on the inflation rate, and they refer to the component of $(y - y^*)$ in the modern PC.

Figure 3.3 exhibits the variables that represent cost shocks. Figure 3.3(a) indicates the foreign exchange rate in the US Dollar. Besides, the effect of the exchange rate is also seen in panel (b) because this series is the product of the European Brent Oil Prices (per barrel) and the exchange rate series in panel (a). We use EXC to see the cost pressure on prices in the models. Also, OIL replaces the EXC in the model for the CPI_4 because this subgroup includes the energy that the households use, and prices of them have similar patterns with oil prices (Ertuğ and Özmen, 2020).

(a): EXC: Exchange Rate in USD	(b): OIL: Europe Brent Oil Prices in TL

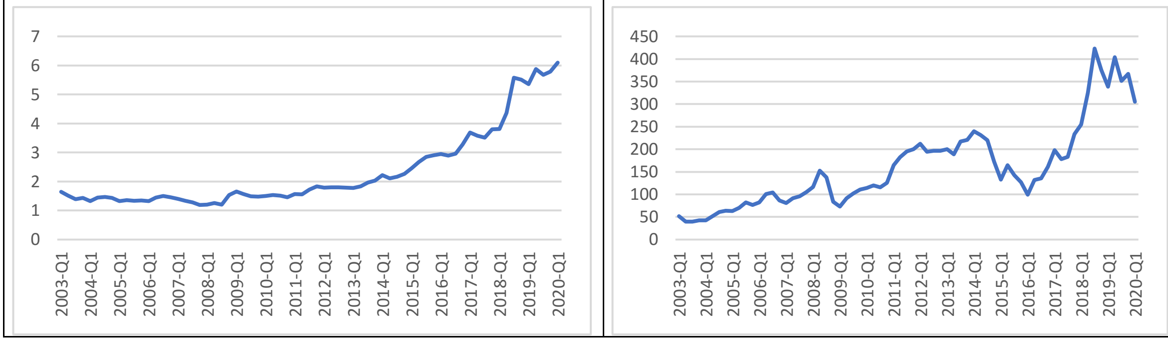


Figure 3.3. *Independent Cost Variables (EDDS, 2020)*

The baseline model in the previous subsection includes three variables that drive inflation: inertia, output gap, and cost shocks. Figure 3.1-3.3, respectively, represents these variables, and they are involved in all the models. The lagged values of the CPI series in Figure 3.1 explore the backward-looking indexation in each model. As the demand indicator, we choose the option that produces the best model even though both output gap measures are not significant in some models. Besides, the exchange rate catches the cost shocks on prices in each model. In addition to these, we employ the sector-specific variables in the models to reveal the idiosyncratic effects that explain the pricing dynamics in various subgroups and to strengthen the models.

For instance, in CPI_0, the import unit price index (2010=100), IMP, enters the model to reveal the effects of import prices in the general CPI. Based on the optimum lags that AIC suggest, we estimate the following aggregated Phillips curve:

$$CPI_0 = \beta_{00} + \beta_{01}\sum_{i=1}^{4} CPI_{0_{t-i}} + \beta_{02}\sum_{i=0}^{0} GAP_{m_{t-i}} + \beta_{03}\sum_{i=0}^{0} EXC_{t-i} + \beta_{04}\sum_{i=0}^{0} IMP_{t-i} \tag{3.5}$$

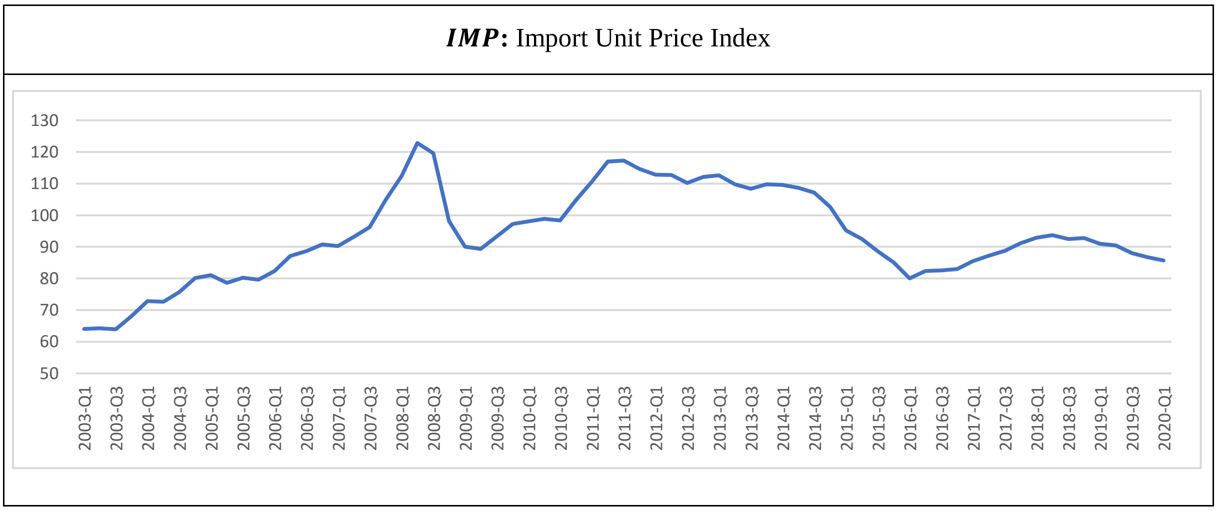


Figure 3.4. *Import Unit Price Index (EDDS, 2020)*

Also, we utilize the related subcomponents of IMP to explain pricing behaviors in sub-groups. For instance, in CPI_1, we try to examine the changes in food prices by using the import of unprocessed food materials, IMP_f, and the ratio of the agricultural sector to the overall GDP, AGR. Also, because preliminary estimation for CPI_1 signifies structural break, we create a dummy variable for the period of 2010Q1-2013Q2. Based on the AIC, the estimated model, which is called Model 1, is the following model:

$$CPI_1 = \beta_{10} + \beta_{11} \sum_{i=1}^{2} CPI_{1_{t-i}} + \beta_{12} \sum_{i=0}^{0} GAP_{m_{t-i}} + \beta_{13} \sum_{i=0}^{1} EXC_{t-i} + \beta_{14} \sum_{i=0}^{0} IMP_{f_{t-i}} + \beta_{15} \sum_{0}^{2} AGR_{t-i} + \beta_{16} \sum_{i=0}^{4} D_{t-i} \quad (3.6)$$

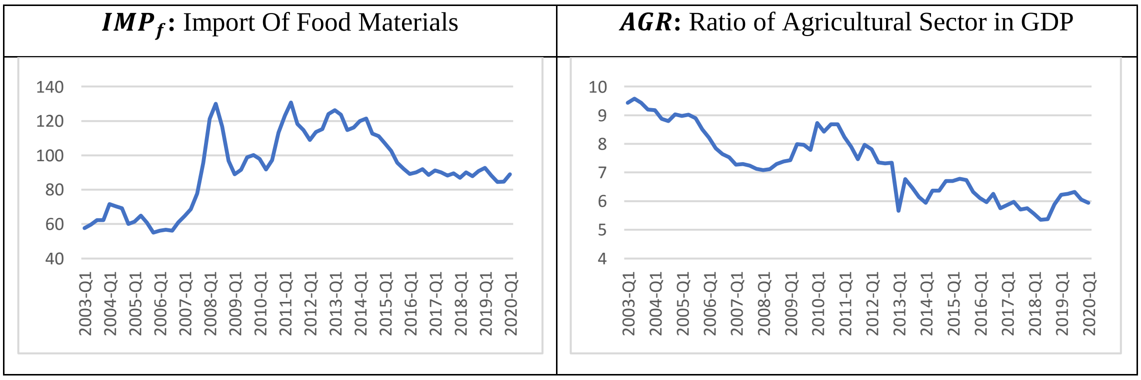


Figure 3.5. *Sector-specific Explanatory Variables of Model 1 (EDDS, 2020)*

Moreover, the following model aims to explain the inflation dynamics in clothing and footwear prices. For that purpose, we draw the related subcomponent of the import unit price index, that is, the import of semi-durable goods, IMP_s. Also, to see the effects of related domestic production, we create a variable, IPI_w, which is the average of three subcomponents of the IPI: textiles, wearing, and leather. However, the estimated model of this group generates a structural break. Then we employ a dummy variable for the post-2017 period. In following, SC gives the following Model 2:

$$CPI_3 = \beta_{31}\sum_{i=1}^{3} CPI_{3_{t-i}} + \beta_{32}\sum_{i=0}^{0} GAP_{y_{t-i}} + \beta_{33}\sum_{i=0}^{2} EXC_{t-i} + \beta_{34}\sum_{i=0}^{1} IMP_{s_{t-i}} + \beta_{35}\sum_{0}^{2} IPI_{w_{t-i}} + \beta_{36}\sum_{i=0}^{0} D_{t-i} \quad (3.7)$$

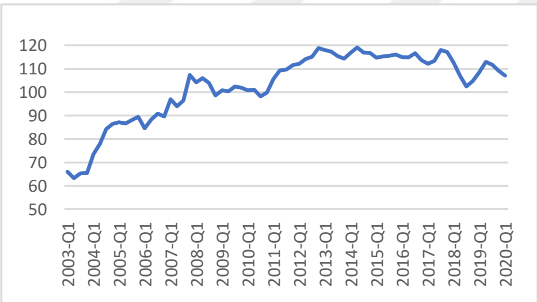
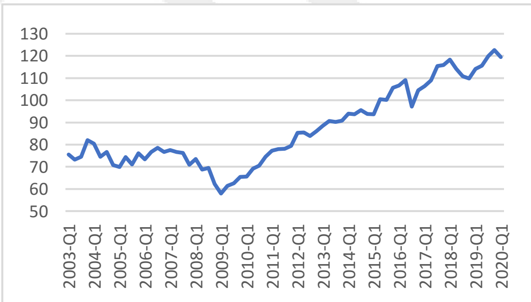
<table>
<tr><th>$\boldsymbol{IMP_s}$: Import of Semi-durable Goods</th><th>$\boldsymbol{IPI_w}$: Average Production Index for Clothing and Footwear</th></tr>
<tr><td>
</td><td>
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Figure 3.6. *Sector-specific Explanatory Variables of Model 2 (EDDS, 2020)*

CPI_4 is mostly determined by rent prices and energy prices that are used in houses such as electricity, gas, and water. Since these energy prices have a similar pattern with oil prices, OIL enters the Model 3. This variable includes the effects of both movements in the exchange rate and oil prices. Besides, the average interest rate on housing exists in this model to catch the relationship between rental prices and the interest rate. Consequently, the following model is estimated based on the AIC:

$$CPI_4 = \beta_{40} + \beta_{41} \sum_{i=1}^{4} CPI_{4_{t-i}} + \beta_{42} \sum_{i=0}^{4} GAP_{m_{t-i}} + \beta_{43} \sum_{i=0}^{2} OIL_{t-i} + \beta_{44} \sum_{i=0}^{4} INT_{h_{t-i}} \quad (3.8)$$

$\boldsymbol{INT_h}$: Average Interest Rate on Housing

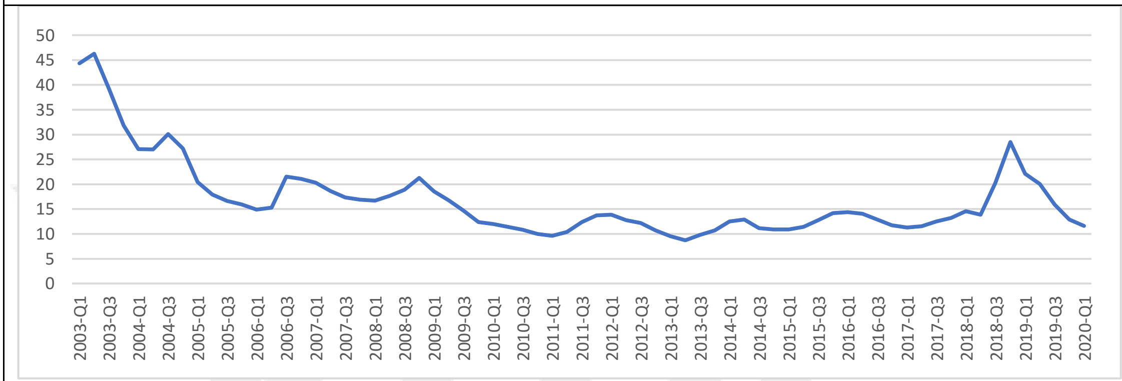


Figure 3.7. *Sector-specific Explanatory Variables of Model 3 (EDDS, 2020)*

Also, a big part of CPI_5 is composed of several goods that households use like white goods. Since these goods are counted as durable goods, the durable goods in the import unit price index, IMP_d, is drawn to reveal pricing dynamics in this sub-group. Also, considering the structural breaks in the first estimation, a dummy variable for 2016-2017 is included in the model. Then, AIC produces the following model:

$$CPI_5 = \beta_{51} \sum_{i=1}^{4} CPI_{5_{t-i}} + \beta_{52} \sum_{i=0}^{3} GAP_{m_{t-i}} + \beta_{53} \sum_{i=0}^{0} EXC_{t-i} + \beta_{54} \sum_{i=0}^{4} IMP_{d_{t-i}} + \beta_{55} \sum_{i=0}^{4} D_{t-i} \quad (3.9)$$

***IMP_d*: Import of Durable Goods**

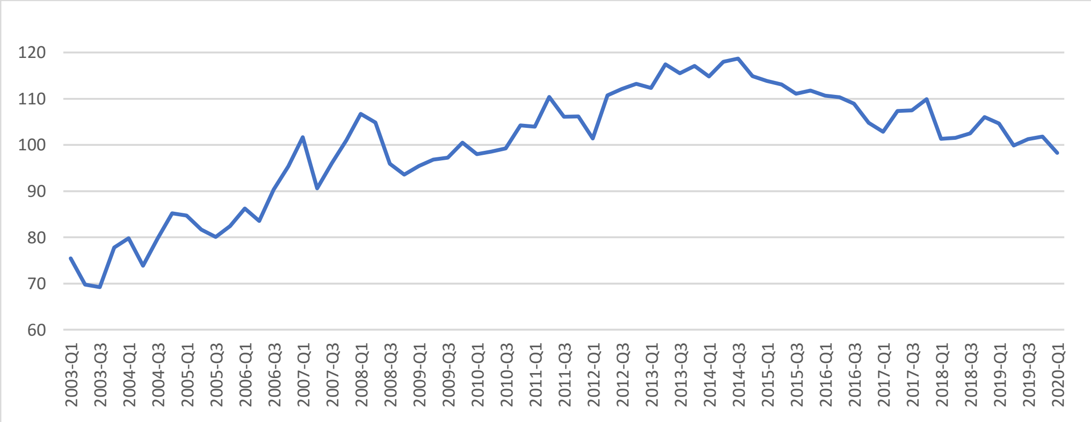
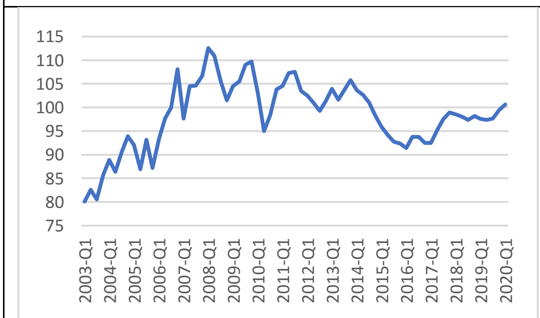


Figure 3.8. *Sector-specific Explanatory Variables of Model 4 (EDDS, 2020)*

Furthermore, CPI_7 includes the prices related to transportation. Therefore, we employ the import of materials that are used in vehicles, IMP_v. On the other hand, the interest rate is an important variable that affects the prices of transportation through vehicle prices. For that reason, we also use the average interest rate in vehicles, INT_v. Then, SC produces the following model:

$$CPI_7 = \beta_{71} \sum_{i=1}^{2} CPI_{7_{t-i}} + \beta_{72} \sum_{i=0}^{3} GAP_{m_{t-i}} + \beta_{73} \sum_{i=0}^{0} EXC_{t-i} + \beta_{74} \sum_{i=0}^{0} IMP_{v_{t-i}} + \beta_{75} \sum_{i=0}^{1} INT_{v_{t-i}} \quad (3.10)$$

***IMP_v*: Import of Materials of Vehicles**



***INT_v*: Average Interest Rate on Vehicles**

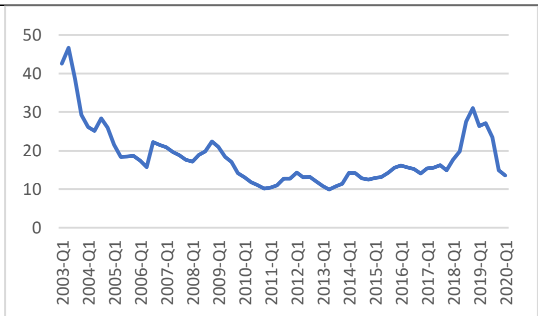


Figure 3.9. *Sector-specific Explanatory Variables of Model 5 (EDDS, 2020)*

Finally, we estimate a model that explains the pricing dynamics in hotels and restaurants. In addition to the standard explanatory variables, we also test the effects of the number of tourists on CPI_{11} because the big part of the demand in this group comes from tourists. Based on the AIC and the dummy variable that explains the structural break in the year 2017, the model for CPI_{11} is

$$CPI_{11} = \beta_{110} + \beta_{111}\sum_{i=1}^{3} CPI_{11_{t-i}} + \beta_{112}\sum_{i=0}^{1} GAP_{m_{t-i}} + \beta_{113}\sum_{i=0}^{0} EXC_{t-i} + \beta_{114}\sum_{i=0}^{0} TOU_{t-i} + \beta_{115}\sum_{i=0}^{4} D_{t-i} \quad (3.11)$$

***TOU*:** Number of Tourists (in thousands)

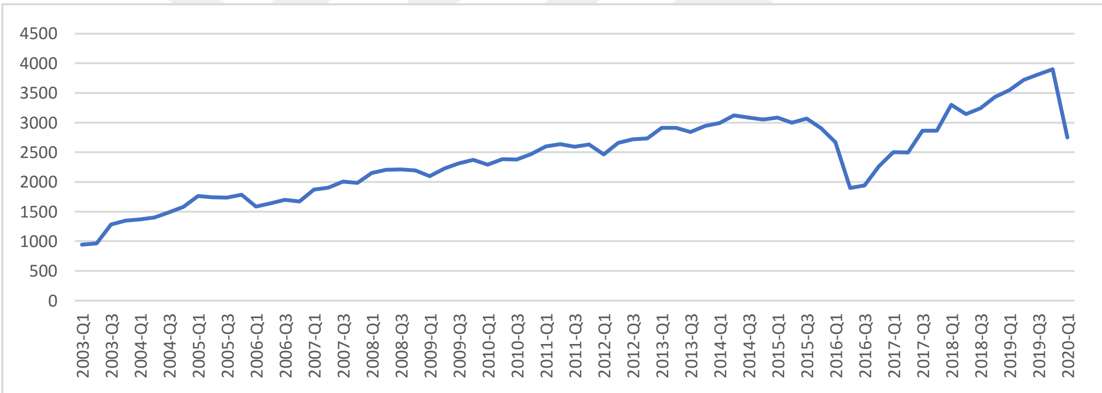


Figure 3.10. *Sector-specific Explanatory Variables of Model 6 (EDDS, 2020)*

On the other hand, a reliable econometric analysis necessitates stationary time-series. For that reason, we apply two different tests for a double-check of the stationarity. Table 3.3 presents the results of these tests. In this table, ADF and PP respectively refer to Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests. As mentioned earlier, some variables may be stationary in level, I(0), and some other variables may be stationary in first differences, I(1), in the ARDL model. According to the ADF results, almost all variables are stationary in I(1) at 0.01 significance level except one variable. CPI_5 is stationary at 0.1 significance levels. On the other hand, PP results indicate that all variables are stationary in I(1) at 0.01 significance level. In summary, the results of the unit root analyses report that all variables are proper to use in the models.

Table 3.3. *Unit Root Tests*

UNIT ROOT TESTS				
	ADF		PP	
Variables	Level	First Differences	Level	First Differences
CPI_0	1.7422 (0.9996)	-8.1128 (0.0000)	1.7392 (0.9996)	-8.1257 (0.0000)
CPI_1	1.6832 (0.9996)	-7.8141 (0.0000)	1.6832 (0.9996)	-7.8429 (0.0000)
CPI_3	3.7138 (1.0000)	-4.7672 (0.0002)	2.3050 (1.0000)	-4.9721 (0.0001)
CPI_4	0.0379 (0.9584)	-6.7978 (0.0000)	0.0296 (0.9576)	-6.7109 (0.0000)
CPI_5	1.6341 (0.9995)	-2.8056 (0.0630)**	2.0272 (0.9999)	-4.8198 (0.0002)
CPI_7	0.6759 (0.9908)	-5.9248 (0.0000)	0.6395 (0.9899)	-5.7255 (0.0000)
CPI_{11}	-0.3949 (0.9034)	-4.9205 (0.0001)	-0.3129 (0.9168)	-4.8520 (0.0002)
GAP_m	-3.3820 (0.0150)*	-7.4243 (0.0000)	-3.5625 (0.0091)	-7.4088 (0.0000)
GAP_y	-2.9260 (0.0476)*	-7.3441 (0.0000)	-3.1192 (0.0298)*	-7.3203 (0.0000)
EXC	1.7360 (0.9996)	-7.2414 (0.0000)	1.8119 (0.9997)	-7.2320 (0.0000)
OIL	-1.2422 (0.6514)	-7.1258 (0.0000)	-1.2646 (0.6413)	-7.0744 (0.0000)
IMP	-2.8814 (0.0529)**	-5.0511 (0.0001)	-2.4006 (0.1454)	-4.2760 (0.0011)
IMP_f	-1.9619 (0.3027)	-5.2522 (0.0000)	-2.0165 (0.2792)	-4.2680 (0.0011)
IMP_s	-3.1648 (0.0265)*	-3.5375 (0.0100)	-3.3713 (0.0155)*	-7.3634 (0.0000)
IMP_d	-2.1604 (0.2225)	-7.2708 (0.0000)	-2.2308 (0.1975)	-9.0631 (0.0000)
IMP_v	-3.0574 (0.0347)*	-9.3650 (0.0000)	-3.0283 (0.0372)*	-9.6007 (0.0000)
INT_h	-3.5766 (0.0088)**	-5.2710 (0.0000)	-2.8363 (0.0586)**	-5.2526 (0.0000)
INT_v	-3.4921 (0.0112)*	-5.9715 (0.0000)	-2.7203 (0.0758)**	-5.9975 (0.0000)
AGR	-1.6419 (0.4559)	-10.766 (0.0000)	-1.5102 (0.5225)	-10.682 (0.0000)
IPI_w	-0.2140 (0.9309)	-9.3179 (0.0000)	-0.0980 (0.9449)	-9.2743 (0.0000)
TOU	-3.0217 (0.0379)	-6.4923 (0.0000)	-3.0148 (0.0385)	-6.4969 (0.0000)
Note: * and ** respectively refer to variables that are stationary at %5 and %10 significance level. All other variables are stationary at %1 significance level.				

3.4. Estimation Results

This subsection presents the estimation results of the above ARDL models and their numerous residual and stability diagnostic tests. In the following subsections, the first tables indicate the models' coefficients and results of diagnostic tests. LM tests aim to find if there is an autocorrelation problem in models. Also, ARCH results indicate whether models provide the assumption of homoscedasticity or do not. Besides, the normality test is employed to see if the model has a normal distribution. Finally, the results of Ramsey RESET tests indicate if there is a specification error in the models.

Results of all diagnostic tests verify the consistency of models. Moreover, the results of long-run models follow the ARDL estimation results for each subgroup. Also, figures in each subsection present CUSUM results that confirm the stability of the models.

Table 3.4. *Results of the F-Bounds Tests*

Cointegration Coefficients of Error Correction Models				
Models	**F-statistics**	**Lower Bound**	**Upper Bound**	**Result**
Model 0	20.5122	3.65	4.66	COINTEGRATION
Model 1	15.5814	3.29	4.37	COINTEGRATION
Model 2	4.0782	2.14	3.34	COINTEGRATION
Model 3	13.1892	2.79	3.67	COINTEGRATION
Model 4	7.5497	2.26	3.48	COINTEGRATION
Model 5	11.2140	2.26	3.48	COINTEGRATION
Model 6	8.9400	2.26	3.48	COINTEGRATION

Table 3.4 exhibits the result of the F-bounds test for all models as a preliminary analysis. The results in the table confirm the existence of a long-run relationship in each model. Furthermore, cointegration coefficients in Table 3.5 document the speed of adjustment to the long-run equilibrium. According to these results, this speed varies from 2 to 5 years across models. Also, Model 3 and Model 5 respectively perform the lowest and highest speed of adjustment to the long-run equilibrium. Besides, these cointegration coefficients meet the necessary condition for the significance, as all coefficients are negative and statistically significant.

Table 3.5. *Cointegration Coefficients of Error Correction Models*

Cointegration Coefficients of Error Correction Models			
Models	**Coefficient**	**t-statistic**	**Prob.**
Model 0	-0.1114	-10.4765	0.0000
Model 1	-0.0781	-10.1408	0.0000
Model 2	-0.1259	-5.1747	0.0000
Model 3	-0.0198	-8.4523	0.0000
Model 4	-0.0809	-6.4055	0.0000
Model 5	-0.1840	-7.7508	0.0000
Model 6	-0.0243	-6.9335	0.0000

3.4.1. Model 0: The aggregated Phillips curve

This model is the aggregated PC with lagged values of the CPI_0, the output gap, and shock variables. In the model, the first and fourth lagged values of CPI_0 have a significant effect on current prices. Considering that the frequency of the data is quarterly, it concludes that prices of the previous year positively affect today's prices. Also, the model produces an output gap measure that is both economically and statistically insignificant. Moreover, the exchange rate and import prices have a substantial effect on prices. According to the results, %1 increase in each of these variables affects the CPI_0 approximately %0.10 without lag. This finding is remarkable because it indicates that the exchange rate and import price pass-through on prices swiftly occur.

Table 3.6. *ARDL Results of Model 0*

ARDL(4,0,0,0) **R-squared: 0.9993**	
Variables	**Coefficients (prob.)**
C	0.0833 [0.1056]
CPI_0 (-1)	0.6063 [0.0000]
CPI_0 (-2)	0.0230 [0.8596]
CPI_0 (-3)	-0.1326 [0.3094]
CPI_0 (-4)	0.3917 [0.0000]
GAP_m	-0.0249 [0.6028]
EXC	0.1096 [0.0000]
IMP	0.1032 [0.0000]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	1.5409 [0.2197]
LM (2)	0.7755 [0.4654]
Heteroscedasticity	
ARCH (1)	0.2542 [0.6159]
ARCH (2)	0.2944 [0.7460]
Jarque-Bera Normality	1.0181 [0.6010]
Ramsey RESET	0.2057 [0.6519]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values. Values for autocorrelation, heteroscedasticity, and Ramsey RESET tests are F-statistics.	

On the other hand, the long-run model (3.12) shows that the exchange rate and the import dynamics have a significant influence on inflation in the long-run. Their coefficients are respectively 0.98 and 0.92. The output gap acts the same as the previous model, but it may be acceptable because we do not expect a relationship between the output gap and inflation in the long-run, as the theory says.

$$CPI_0 = \underbrace{0.7477}_{(0.0892)} - 0.2240\underbrace{GAP_m}_{(0.5935)} + \underbrace{0.9832EXC}_{(0.0000)} + \underbrace{0.9258IMP}_{(0.0000)} \quad (3.12)$$

The results of the model support the descriptive analyses in the first section by verifying the existence of the backward-looking indexation mechanism on pricing behaviors and the crucial effects of the exchange rate and import prices on inflation. Also, the output gap fails to explain inflation both in the short-run and long-run. Finally, all the coefficient and stability diagnostic tests reveal the robustness of the model (Table 3.6 and Figure 3.11)

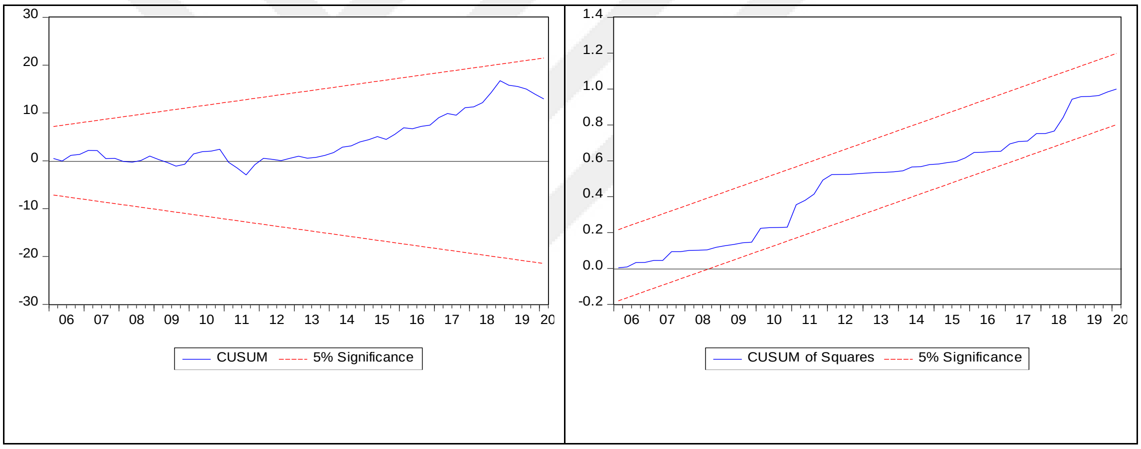


Figure 3.11. *CUSUM Results of the Model 0*

3.4.2. Model 1: Food and non-alcoholic beverages

Model 1 is the first part of disaggregated PC's. It examines the inflation dynamics of food and non-alcoholic beverages. This group has the highest weight on the CPI, and it is one of the biggest drivers of the general price level according to several studies, including Erol (2017) and Lopcu and Şengül (2018). Alongside its high weights in the consumption basket, the low demand elasticity of prices makes this group a crucial driver. The results of the model give remarkable insights about these characteristics. Firstly, this model produces the relatively highest constant variable across the subcomponents. This result can be attributed to the necessity of food consumption for households, independent of economic indicators. Also, the results of the model indicate that the backward-looking indexation is significant in CPI_1. The first and second lag of CPI_1 positively affect prices. In contrast to Model 0, there is a positive relationship between the output gap and the prices in this group. Besides, while the effect of exchange rate realizes with one period lag, the import prices of unprocessed foods immediately affect the prices in CPI_1.

Table 3.7. *ARDL Results of Model 1*

ARDL [2,0,1,0,2,4] **R-squared: 0.9993**	
Variables	**Coefficients [prob.]**
C	1.2053 [0.0000]
CPI_1 (-1)	0.4276 [0.0008]
CPI_1 (-2)	0.3659 [0.0013]
GAP_m	0.3584 [0.0000]
EXC	0.0583 [0.0678]
EXC (-1)	0.0802 [0.0304]
IMP_f	0.0767 [0.0003]
AGR	0.0234 [0.5257]
AGR (-1)	-0.0466 [0.2873]
AGR (-2)	-0.2422 [0.0000]
D	0.0591 [0.0001]
D (-1)	-0.0247 [0.1147]
D (-2)	0.0224 [0.1146]
D (-3)	-0.0014 [0.9174]
D (-4)	-0.0253 [0.0196]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	0.2733 [0.6035]
LM (2)	0.1342 [0.8747]
Heteroscedasticity	
ARCH (1)	0.0888 [0.7667]
ARCH (2)	0.0976 [0.9071]
Jarque-Bera Normality	1.5643 [0.4574]
Ramsey RESET	1.1781 [0.2444]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values Values for autocorrelation, heteroscedasticity, and Ramsey RESET tests are F-statistics.	

In addition to these, we try to catch the relationship between agricultural production and food prices. For that purpose, we employ the share of the agricultural output to the overall GDP. Only the coefficient of the second lag of this variable is significant, and it supports the general idea that the magnitude of the agricultural sector affects the food prices (Aydoğuş, 2020). In this model, a %1 decrease in the share of the agricultural sector in GDP leads to a %0.24 rise in the prices of food and non-alcoholic beverages with a two-quarter lag. Also, the model gives four lags for the dummy variable that tries to explain the structural break between 2010-2013, following the GFC (Figure 3.12). Even though the dummy variable solves the structural break problem of the model, it is only significant in the fourth lag, and the level of significance is weak. In contrast, its significance level is higher in the long-run model.

Equation (3.13) gives the long-run model for CPI_1. The effect of the constant is also very high in the long -run. It corroborates our previous analysis of this variable. Besides, the impact of the output gap is economically and statistically significant in the long run, too. These results are impressive because the effects of constant and the output gap variables are relatively rare in other models. In addition to these, the impact of the exchange rate and related import prices proceed in the long-run. Also, the performance of the dummy variable is relatively better in the long run. This case is consistent with the ECM results in Table 3.5. Both the active length of the dummy variable and the time to reach the long-run is around three years in Model 1. So, the effect of the dummy variable arises in the long run.

$$CPI_1 = \underbrace{5.8391}_{(0.0000)} + \underbrace{1.7366GAP_m}_{(0.0000)} + \underbrace{0.6715EXC}_{(0.0000)} + \underbrace{0.3716IMP_f}_{(0.0000)} - \underbrace{1.2857AGR}_{(0.0000)} + \underbrace{0.1450D}_{(0.0005)} \quad (3.13)$$

Overall, Model 1 gives some essentials about food prices in Turkey. First, there is a backward-looking indexation in food prices. Also, the effect of demand on prices strongly arises both in the short-run and long run. This finding may be the result of the inelastic demand preferences of consumers on foods. Also, foreign shocks to food prices come from the exchange rate and the import prices of unprocessed food materials. This result is consistent with the Erol (2017). Finally, the decrease in the share of the agricultural sector creates pressure on the food prices in the domestic economy in the long-run.

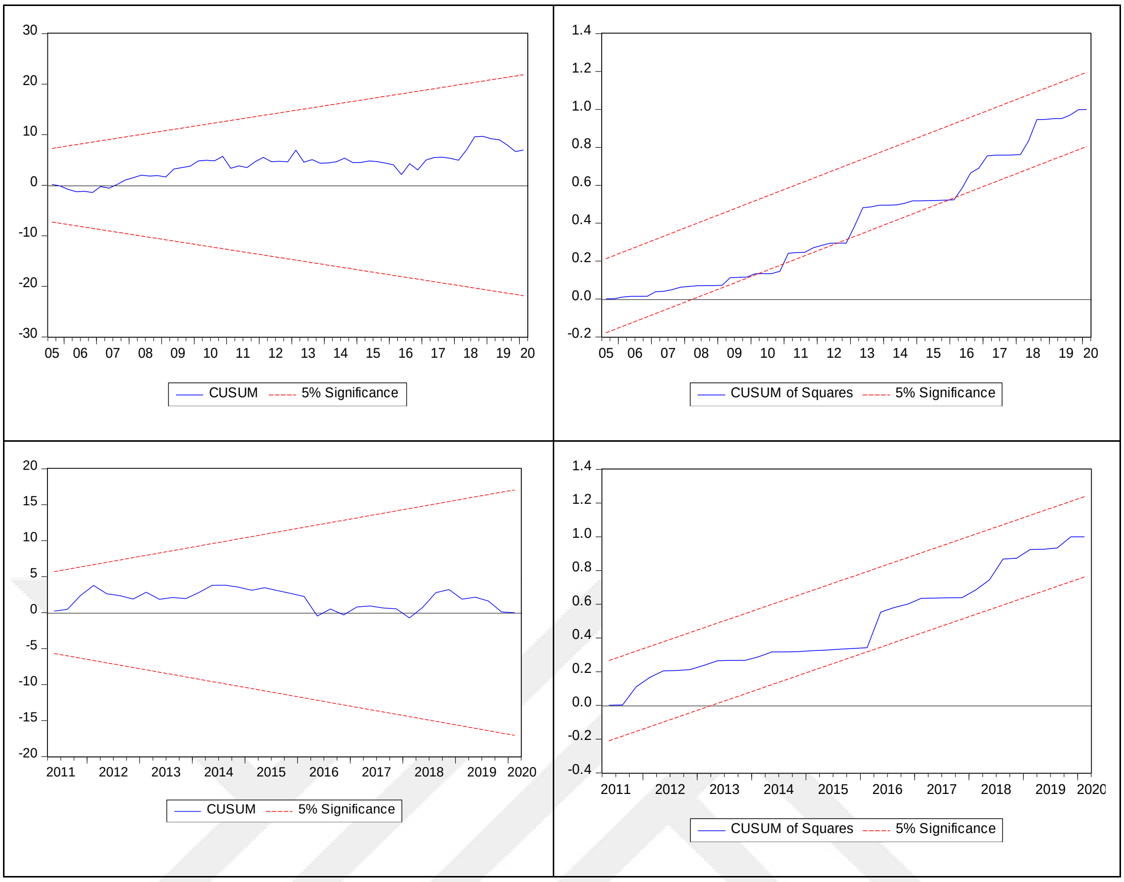


Figure 3.12. *CUSUM Results of the Model 1*

3.4.3. Model 2: Clothing and footwear

CPI_3 is the group with the lowest level of increase across subcomponents of the CPI. Differently from Model 0 and 1, only the first lag of the CPI_3 is significant. Also, the output gap fails to explain changes in clothing and footwear prices. Besides, the effect of the exchange rate is seen with one-period lag. So, exchange rate indexation is relatively weaker in this group. Similarly, the impact of import prices of semi-durable goods arises with a lag. In addition to these, we create a specific variable for this subgroup to see the effect of supply dynamics. We average the related subcomponent of the IPI: production index of clothing, textile, and leather. The impact of the produced variable of IPI_w on wearing prices is weird. All the coefficients of IPI_w are significant, but its sign varies across lags. Furthermore, the TSI changed the calculation method in this group in 2017. While it used month by month changing weights before 2017, this method is replaced by a constant weight approach in the group of wearing due to the seasonal behavior of this group. Depending on the change in calculating way, we use a dummy variable for the period after 2017. The effect of this dummy variable positively and significantly affect prices on CPI_3 both in the short-run and long-run. It also solves the structural break problem in the model (Figure 3.13).

Table 3.8. *ARDL Results of Model 2*

ARDL [3,0,2,1,2,0] **R-squared: 0.9995**	
Variables	**Coefficients (prob.)**
CPI_3 (-1)	1.1171 [0.0000]
CPI_3 (-2)	0.1820 [0.2791]
CPI_3 (-3)	-0.4251 [0.0001]
GAP_y	-0.4251 [0.0952]
EXC	0.0101 [0.4935]
EXC (-1)	0.0552 [0.0064]
EXC (-2)	-0.0386 [0.0084]
IMP_s	0.0011 [0.9697]
IMP_s (-1)	0.0714 [0.0177]
IPI_w	0.0506 [0.0263]
IPI_w (-1)	0.0788 [0.0024]
IPI_w (-2)	-0.0684 [0.0012]
D	0.0125 [0.0068]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	0.0041 [0.9488]
LM (2)	0.4022 [0.6709]
Heteroscedasticity	
ARCH (1)	1.9005 [0.1729]
ARCH (2)	2.2194 [0.1174]
Jarque-Bera Normality	0.7768 [0.6781]
Ramsey RESET	0.1954 [0.8458]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values. Values for autocorrelation, heteroscedasticity, and Ramsey RESET tests are F-statistics.	

According to the long-run model of equation (3.14), the effect of the exchange rate in this group is relatively lower. On the other hand, the import of semi-durable goods significantly affects the wearing prices in the long run. So, in this group, the foreign shocks come from the related import prices rather than the exchange rate indexation. On the other hand, the effect of the corresponding production index contradicts the economic theory. According to the long-run results, a rise in the production cause upward pressure on the prices of CPI_3.

$$CPI_3 = \underbrace{-0.3229GAP_y}_{(0.0391)} + \underbrace{0.2127EXC}_{(0.0000)} + \underbrace{0.5762IMP_s}_{(0.0000)} + \underbrace{0.4848IPI_w}_{(0.0000)} + \underbrace{0.0978D}_{(0.0042)} \quad (3.14)$$

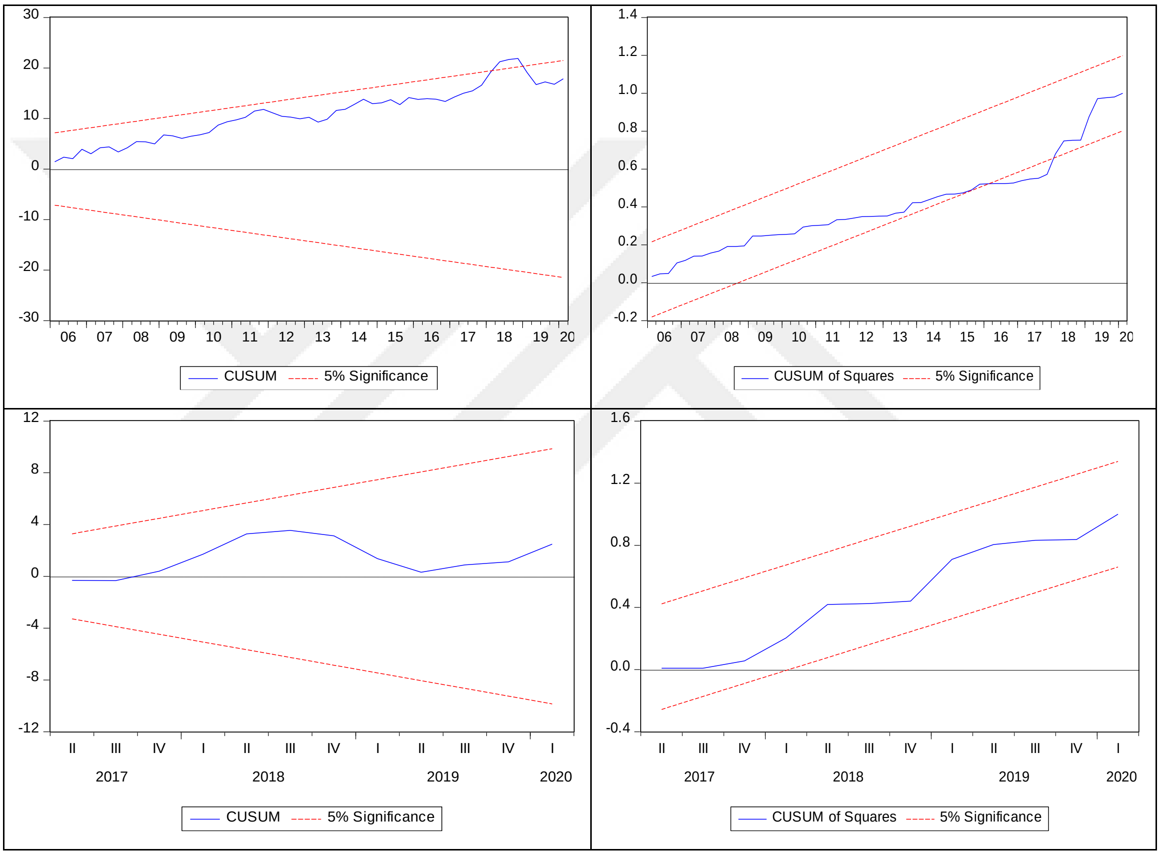


Figure 3.13. *CUSUM Results of the Model 2*

3.4.4. Model 3: Housing, water, electricity, gas, and other fuels

This subgroup includes prices that are related to housing. Considering the content of the group that Table 3.1 presents, oil prices and the interest rate on housing enters the model as explanatory variables. In this model, EXC replaces by OIL since we aim to explain the effect of oil prices on the energy prices that households use and the effect of interest rates on rental prices. Based on the results in Table 3.9, the first lagged variable of CPI_4 has a significant effect. The fourth lag is also positive, but its significance level is relatively low. Also, a positive output gap creates pressure on the prices with one year lag. Since the government generally determines the housing energy prices, this demand pressure probably comes from renting. Besides, the effect of demand on prices manifests itself with a four-quarter lag since rents are usually contracted. Moreover, the movements in the oil price also affect the prices on CPI_4 with one-quarter lag. This lagging makes sense because transmission from the oil prices to the domestic energy prices takes time.

Table 3.9. *ARDL Results of Model 3*

ARDL [4,4,1,4] R-squared: 0.9991	
Variables	**Coefficients (prob.)**
C	-0.1371 [0.0083]
CPI_4 (-1)	0.8385 [0.0000]
CPI_4 (-2)	-0.0465 [0.7995]
CPI_4 (-3)	-0.0160 [0.9224]
CPI_4 (-4)	0.2043 [0.0798]
GAP_m	0.0490 [0.6127]
GAP_m (-1)	0.0387 [0.7655]
GAP_m (-2)	-0.4057 [0.0054]
GAP_m (-3)	0.1341 [0.3692]
GAP_m (-4)	0.2440 [0.0314]
OIL	-0.2284 [0.1009]
OIL (-1)	0.0532 [0.0006]
INT_h	0.0848 [0.0002]
INT_h (-1)	-0.0289 [0.4308]
INT_h (-2)	-0.0355 [0.3612]
INT_h (-3)	-0.0102 [0.7860]
INT_h (-4)	0.0387 [0.1055]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	0.0662 [0.7980]
LM (2)	0.8549 [0.4320]
Heteroscedasticity	
ARCH (1)	0.0755 [0.7844]
ARCH (2)	0.0427 [0.9582]
Jarque-Bera Normality	5.9133 [0.0519]
Ramsey RESET	0.6717 [0.5050]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values.	

In addition to these, CPI_4 includes the rental prices that can be affected by house prices. One of the most critical determinants of house prices is the interest rate since most house sales are made using long-term credits. Therefore, decreases in interest rates increase house prices in the very short-term. However, the model does not catch a similar effect on prices. The results indicate a positive relationship between CPI_4 and INT_h in the same period. Even though the sign of the lag coefficients is negative, they are not reliable because the coefficients are insignificant.

Also, equation (3.15) presents long-run results for Model 3. While the statistically insignificant relationship between the interest rate and prices is positive, the driving force of the energy prices on CPI_4 is very strong in the long-run.

$$CPI_4 = \underbrace{-6.9188}_{(0.2020)} + \underbrace{3.0353GAP_m}_{(0.5692)} + \underbrace{1.5353OIL}_{(0.0051)} + \underbrace{2.4667INT_h}_{(0.0869)} \tag{3.15}$$

Finally, the models indicate that there is a positive relationship between CPI_4 and INT_h. This finding contradicts theoretical expectations but, it can be explained under two subjects considering the developments in the related period. First, the group does not directly contain the housing prices since it is a component of the consumption basket where purchasing a house is an investment. So, what we seek out is an indirect effect on rental prices. Second, there may be a positive relationship between house prices and interest rates in the long run because rising house prices meet a policy response that increases interest rates to cut down the demand. The literature includes some studies that support this idea. For instance, this result can be consistent with the finding of Doğan et al. (2016), in which inflation affects the interest rate.

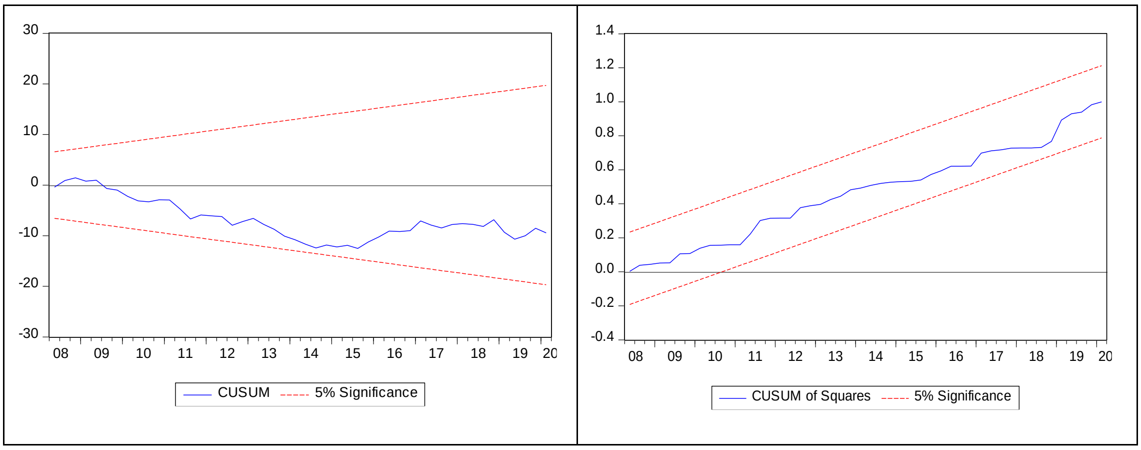


Figure 3.14. *CUSUM Results of the Model 3*

3.4.5. Model 4: Furnishings, Household Equipment, Routine Maintenance of the House

Table 3.10. *ARDL Results of Model 4*

ARDL [4,3,0,4,4] R-squared: 0.9991	
Variables	**Coefficients (prob.)**
CPI_5 (-1)	1.3762 [0.0000]
CPI_5 (-2)	-0.8392 [0.0001]
CPI_5 (-3)	0.6641 [0.0004]
CPI_5 (-4)	-0.2821 [0.0084]
GAP_m	0.0550 [0.5727]
GAP_m (-1)	0.1332 [0.3092]
GAP_m (-2)	-0.2825 [0.0189]
GAP_m (-3)	0.2121 [0.0114]
EXC	0.0556 [0.0114]
IMP_d	0.0973 [0.0476]
IMP_d (-1)	-0.0110 [0.8342]
IMP_d (-2)	0.1029 [0.0479]
IMP_d (-3)	-0.0221 [0.6713]
IMP_d (-4)	-0.0838 [0.0717]
D	0.0055 [0.5803]
D (-1)	-0.0141 [0.2776]
D (-2)	-0.0201 [0.1339]
D (-3)	0.0139 [0.3946]
D (-4)	0.0313 [0.0209]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	0.2676 [0.6074]
LM (2)	1.1639 [0.3217]
Heteroscedasticity	
ARCH (1)	0.0918 [0.7628]
ARCH (2)	0.2313 [0.7942]
Jarque-Bera Normality	0.8482 [0.6543]
Ramsey RESET	0.5339 [0.5940]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values. Values for autocorrelation, heteroscedasticity, and Ramsey RESET tests are F-statistics.	

This model examines the pricing dynamics of goods that households use in houses. Since white goods have a significant share in this group, we employ the import unit price index of durable goods as an explanatory variable. The lag effects of CPI has different patterns in the model. Besides, demand pressure affects the prices with a three-quarter lag. The exchange rate and import prices immediately affect prices as in the previous models. Furthermore, the dummy variable of the model explains the structural break that Figure 3.15 indicates.

In addition to these, the following long-run results of the model are quite familiar. The exchange rate drives inflation in the long-run. However, the effect of imported durable goods on CPI_5 is stronger. Also, while the positive effect of the output gap is insignificant, the dummy variable fails the explain price changes in the long-run.

$$CPI_5 = \underbrace{1.4564GAP_m}_{(0.1590)} + \underbrace{0.6875EXC}_{(0.0000)} + \underbrace{1.0265IMP_d}_{(0.0000)} + \underbrace{0.2031D}_{(0.1050)} \qquad (3.16)$$

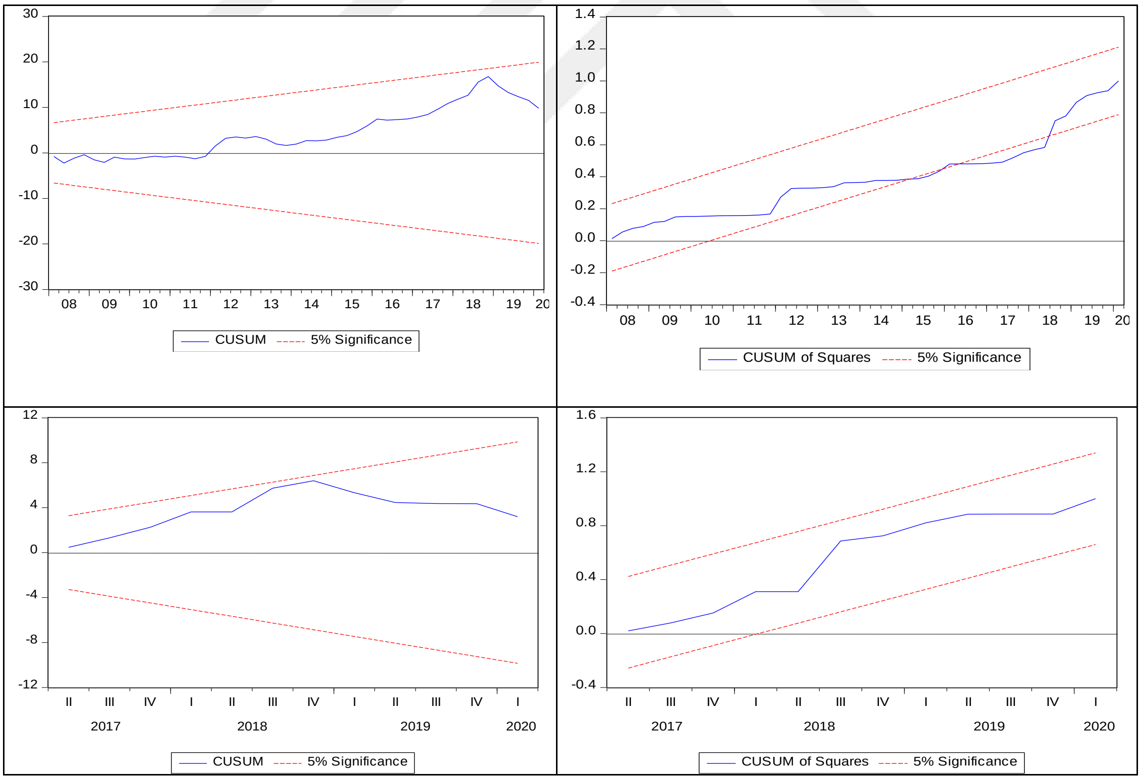


Figure 3.15. *CUSUM Results of the Model 4*

3.4.6. Model 5: Transport

This model analysis transportation prices in Turkey. The exchange rate and oil prices have different effects on this group. First, the exchange rate is crucial because Turkey is an importer country on vehicles. Therefore, changes in the exchange rate directly affect transportation costs through vehicle prices. Second, oil is the most critical cost component of vehicles, and increases in oil prices also reflect transportation costs. So, the exchange rate also indirectly affects transportation prices through this channel.

Table 3.11. *ARDL Results of Model 5*

ARDL [2,3,0,0,1] 0.9984	
Variables	**Coefficients (prob.)**
CPI_7 (-1)	1.1618 [0.0000]
CPI_7 (-2)	-0.3458 [0.0009]
GAP_m	0.1062 [0.3010]
GAP_m (-1)	-0.2341 [0.0957]
GAP_m (-2)	-0.2998 [0.0249]
GAP_m (-3)	0.2821 [0.0065]
EXC	0.1473 [0.0000]
IMP_v	0.2174 [0.0000]
INT_v	0.0355 [0.0749]
INT_v (-1)	-0.0788 [0.0001]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	0.8759 [0.3534]
LM (2)	2.6144 [0.0825]
Heteroscedasticity	
ARCH (1)	1.6079 [0.2094]
ARCH (2)	2.0288 [0.1403]
Jarque-Bera Normality	2.8091 [0.2454]
Ramsey RESET	0.0391 [0.8440]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values.	

According to the results in Table 3.11, the backward-looking indexation in CPI_7 is seen in the first lag. Also, the significant and positive effect of the output gap reveals in the third lag of GAP_m. Besides, the effect of the exchange rate is also significant, and it positively affects the prices in the same period. The import unit price index of materials of vehicles shows a similar pattern with the exchange rate. Furthermore, in contrast to Model 3, the related interest rate has an expected sign in this model. Changes in the interest rate on vehicles negatively affect transportation prices with three months lag.

Moreover, the significant effect of IMP_v continues in the long run. According to the below long-run model, the related imported intermediate goods are the most significant driver of inflation, with a coefficient of 1.18. Also, the exchange rate has a long-run impact on this model, too. Besides, the changes in INT_v negatively affect prices in CPI_7. This finding is consistent with theoretical expectations because a fall in interest rates causes a reduction in the cost of borrowing for vehicles. Then, the decrease in INT_v boosts the CPI_7 through vehicle prices.

$$CPI_7 = \underbrace{-0.7912GAP_m}_{(0.1252)} + \underbrace{0.8005EXC}_{(0.0000)} + \underbrace{1.1817IMP_h}_{(0.0000)} - \underbrace{0.2353INT_h}_{(0.0000)} \quad (3.17)$$

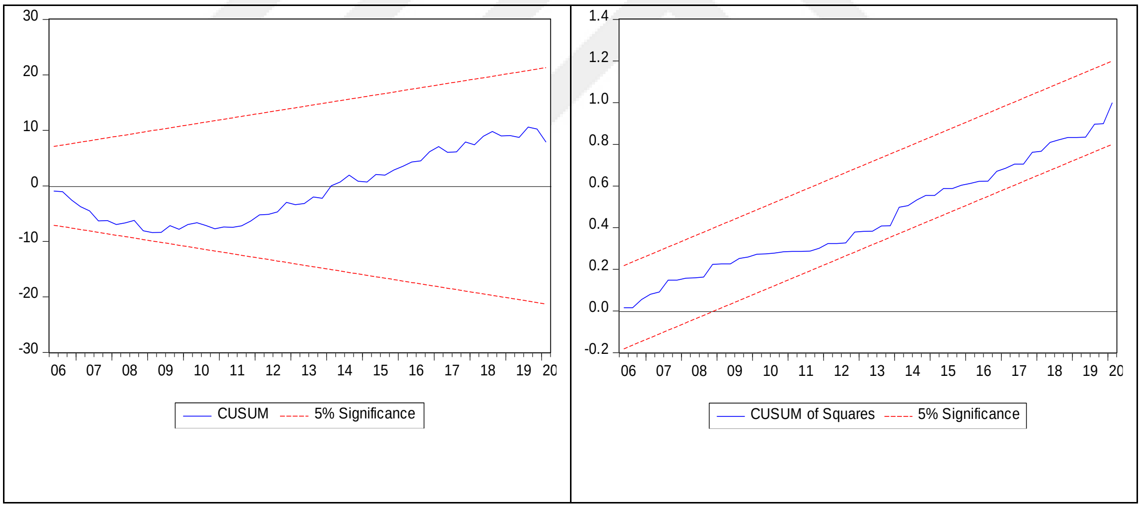


Figure 3.16. *CUSUM Results of the Model 5*

3.4.7. Model 6: Hotels, Cafes, and Restaurants

The last disaggregated model examines the inflation dynamics in hotels, cafes, and restaurants. In the model, the first lag of CPI_{11} indicates the stickiness in prices. Also, the model produces a significant coefficient for the GAP_m. So, the output gap and the movements in the exchange rate affect prices without lag. Moreover, the model includes the number of tourists since hotel prices are a crucial component of this subgroup, and a big part of the demand in this sector comes from the tourists. The results indicate that the number of tourists has a positive effect on CPI_{11}. In addition to these, the model contains a dummy variable for 2017 because of the structural break, which Figure 3.17 represents. The dummy variable corrects the break that may be caused by the domestic developments in Turkey in the corresponding period.

Table 3.12. *ARDL Results of Model 6*

ARDL [3,1,0,0,4] **R-squared: 0.9997**	
Variables	**Coefficients (prob.)**
CPI_{11} (-1)	1.2323 [0.0000]
CPI_{11} (-2)	-0.4260 [0.0314]
CPI_{11} (-3)	0.1694 [0.1900]
GAP_m	0.1126 [0.0327]
GAP_m(-1)	-0.0954 [0.0751]
EXC	0.0200 [0.0240]
TOU	0.0099 [0.0036]
D	0.0062 [0.3732]
D (-1)	-0.0008 [0.9111]
D (-2)	-0.0033 [0.6784]
D (-3)	-0.0102 [0.2556]
D (-4)	0.0219 [0.0056]
DIAGNOSTIC TEST RESULTS	
Autocorrelation	
LM (1)	0.0339 [0.8544]
LM (2)	0.0567 [0.9449]
Heteroscedasticity	
ARCH (1)	0.3924 [0.5333]
ARCH (2)	2.4212 [0.0974]
Jarque-Bera Normality	0.6884 [0.7087]
Ramsey RESET	0.6353 [0.5280]
Note: Numbers in () indicate the lag lengths. Numbers in [] indicate prob. values.	

On the other hand, the long-run model in equation 3.18 reveals that the exchange rate and the number of tourists drives inflation in CPI_{11}. This subgroup is related to tourism, and a big part of the demand for this group comes from foreigners. This foreign demand increases the elasticity for changing prices in proportion to exchange rates since the purchasing power of foreigners is not affected by the change in exchange rates. So, the price-setters in this group can easily index prices based on changes in the exchange rate. This case can explain the extreme price increases in this group. Consequently, both the cost and demand pressure are very strong in the prices of hotels and restaurants.

$$CPI_{11} = \underbrace{0.7081GAP_m}_{(0.6779)} + \underbrace{0.8259EXC}_{(0.0000)} + \underbrace{0.4093TOU}_{(0.0000)} + \underbrace{0.5652D}_{(0.1983)} \qquad (3.18)$$

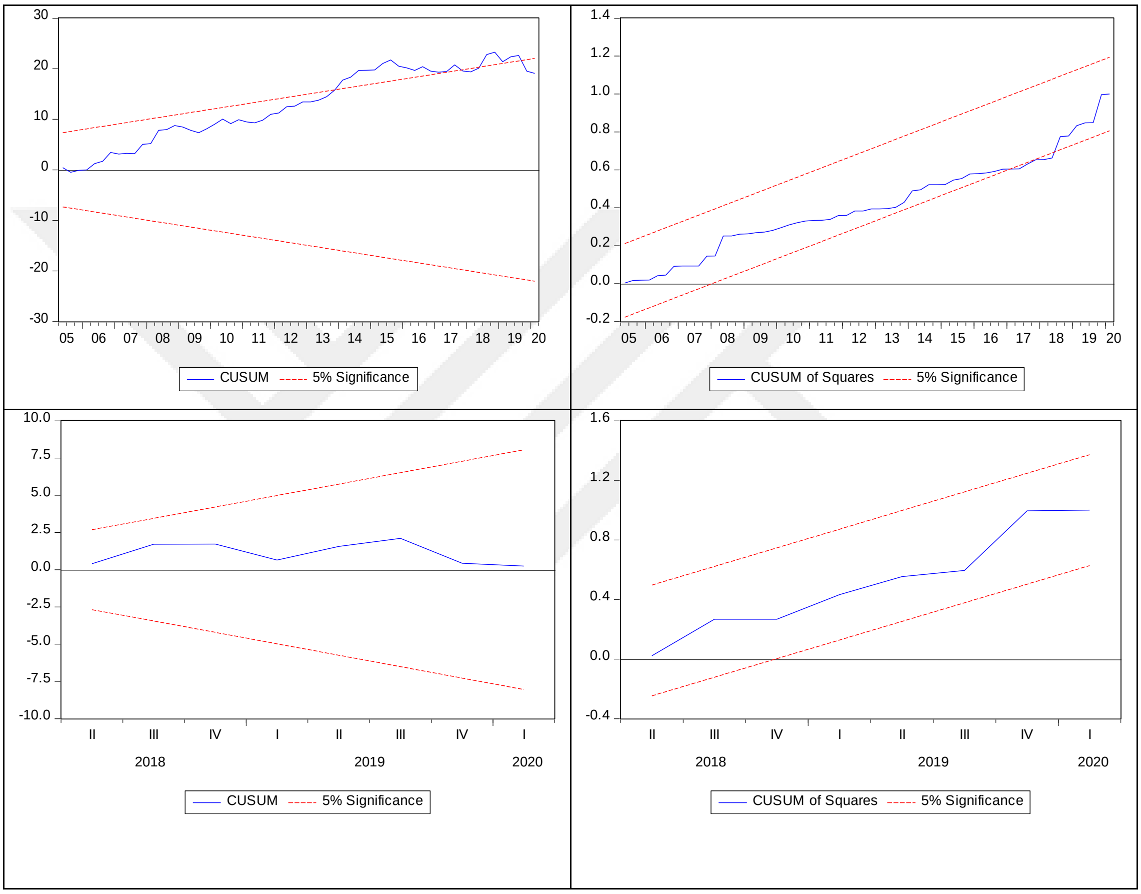


Figure 3.17. *CUSUM Results of the Model 6*

4. CONCLUSION

Inflation dynamics has always been the most discussed topic by many economists and policymakers since it is one of the most critical indicators for the strength of an economy. Besides, the stability of the inflation rate is a more crucial issue for countries that experience high inflation periods. Turkey, as one of these countries, has a long and painful inflation history in the pre-2000 period. This unfortunate history required several structural reforms and switching the IT regime in the Turkish economy. This study focuses on inflation dynamics in Turkey after the implementation of the IT regime.

The first section discusses the inflation rate in the Turkish economy from a historical perspective. The descriptive graphs of this section present valuable insights into Turkish inflation history. First, the Turkish economy experiences very high inflation rates following the liberalization and openness process in the 1980s. However, these policies make the Turkish economy more sensitive to the fluctuations in the international economic dynamics such as movements in the exchange rate. The 1990s continue to witness the inflationary environment with the pressure of political instability. In the following, the Turkish economy switches to the IT regime, and related laws provide the independence of the CBRT. Then, the inflation rate in Turkey falls to a single-digit number after long years, thanks to structural reforms. However, it climbs to double-digits in recent years.

Furthermore, this thesis focuses on the structural inflation problem in Turkey. Descriptive analyses in Section I present several reasons that lie behind the structural inflation problem. One of the most important ones is the high-usage of imported intermediate goods in the production process. For that reason, changes in the exchange rate indirectly affect consumer prices through production costs. Besides, rises in the exchange rate in Turkey also cause growing in oil prices in terms of Turkish Lira. So, the increase in the foreign exchange rate creates another pressure on production costs through oil prices since Turkey is an oil importer country. Moreover, the exchange rate movements directly affect the prices of the final goods and services. Consequently, foreign-source dependency makes the exchange rate the most dominant determinant of the inflation rate in Turkey.

Section II reviews the broad theoretical background of the most commonly used theory to explain inflation dynamics, Phillips curve, born after Phillips' (1958) study.

This theory experiences several evolutions over the years. The natural rate and rational expectations hypotheses emphasize the importance of expectation on inflation dynamics. Also, oil shocks in the 1970s produce the modern PC, which explains inflation dynamics through three drivers: inertia, output gap, and cost shocks. In the following, the NKPC analyzes inflation dynamics in a monopolistic competition framework and considers the sticky prices. Moreover, many authors integrate the dynamics of small open economies to PC analyses.

This study aims to reveal the main drivers of the inflation rate in the Turkish economy by using a disaggregated PC approach and by including open-economy factors such as exchange rate, oil prices, and import unit price index. For that reason, we apply the modern PC framework to the subcomponents of the CPI. Then we estimate one aggregated and six disaggregated PC's.

The results of estimated models in Section III reveals several facts about inflation dynamics in Turkey. First, each model includes significant inertia. Besides, the inertia in the sub-groups is higher than the aggregated model. Also, while the output gap is insignificant in Model 0, sub-models produce a significant relationship between the output gap and the inflation rate with various lags. However, the output gap in Model 2 does not follow the other sub-models. Besides, cost shocks in models are quite remarkable. The movements in the exchange rate and the related import indexes influence prices without lag, in general. It points out that price-setters immediately index prices based on the movements in the exchange rate. Also, the effect of cost shocks is relatively higher on food and accommodation prices. This divergence reveals the crucial roles of these groups on the general inflation rate. However, the results of the models indicate that the significant coefficients of the output gaps are higher than the coefficients of the exchange rate and import prices in the short-run.

In addition to these, some sub-models includes specific explanatory variables. These variables give some additional facts about pricing dynamics. For example, the share of the agricultural sector on GDP negatively affects food prices. Also, a change in the interest rate on vehicles has an adverse impact on the prices of the transportation group. Moreover, tourist numbers positively affect hotel and restaurant prices. So, the economic and statistical significance of these specific variables and the subcomponents of the import unit price index on explaining the price changes in sub-groups of the CPI reveals the advantage of using the disaggregated PC approach. In contrast, an aggregated PC approach does not catch the effects of these specific variables on inflation since it ignores the sui-generis characteristics across subgroups of the CPI.

On the other hand, the long-run inflation dynamics contrast from the short-run results. As the theory suggests, the relationship between inflation and output disappears in the long-run. The only long-run model that produces a significant coefficient for the output gap is Model 1. Since this model examines the prices of food and non-alcoholic beverages, this long-run relationship can be attributed to the inelastic demand of consumers on food consumption. Besides, the effect of the exchange rate and import prices is significantly higher in the long-run models. More clearly, while both demand-pull and cost-push inflation arise in the short-run, the long-run prices are dominantly determined by the cost shocks. Additionally, specific variables of the models, such as agricultural share, interest rates on vehicles, and tourist numbers, have significant effects in the long-run. These long-run findings strengthen the argument that the foreign-source dependency in production and consumption makes inflation a never-ending structural problem for Turkey.

Also, the results suggest several issues to maintain price stability. As the most important one, the foreign-source dependency on the production process must reduce. For this, the Turkish economy should produce intermediate goods to use in production processes. In other words, decreasing the share of the import is essential because it modifies the exchange rate pass-through to consumer prices. Furthermore, increasing the level of technology and productivity in the Turkish economy via education is very crucial to substitute the imported intermediate goods with domestically produced ones. These changes also positively shape inflation expectations and overturn the indexation mechanism in price-setting.

Finally, this thesis defense that inflation is a structural problem in the Turkish economy. The results of the empirical tests support the thesis and reveal the reasons that lie behind this problem, such as the exchange rate, high usage of imported intermediate goods, and dependency on energy sources as input. Also, this study discovers the advantages of applying the disaggregated approach to the PC. This approach may extend in many ways, such as using new variables for different components, non-linear models, or various econometric methods.

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